The Journal of Parasitology

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PROGRAM AND ABSTRACTS OF THE THIRTY-THIRD ANNUAL MEETING OF THE AMERICAN SOCIETY OF PARASITOLOGISTS

BLOOMINGTON, INDIANA

August 24–27, 1958

NOTE: Registration: In Fieldhouse from Sunday through Wednesday. Get Luncheon Tickets at Time of Registration.

PROGRAM[1]

SUNDAY AFTERNOON, AUGUST 24, 2:00 P.M., ROOM 306, UNION BUILDING
COUNCIL MEETING, OFFICERS AND MEMBERS OF THE SOCIETY'S COUNCIL.

(An evening session, if necessary, will convene at 7:30 P.M. in the same room. All Past Presidents of the Society are cordially invited to attend all sessions of the Council).

Monday Morning Session, August 25, 9:00 A.M.
University School Auditorium

Arthur C. Walton, Knox College, PRESIDING

Read

(Authors are requested to keep within the time limits indicated for each paper)

1. Copepods parasitic on starfishes and sea urchins in Madagascar. (10 min.) (Standard lantern). **A. G. Humes,** Boston University, Boston, Mass.

2. A preliminary report on an ecological study of a fish and its parasites. (10 min.) (Standard lantern). **E. R. Noble,** University of California, Santa Barbara College, Goleta, Calif.

3. A review of the genus *Parorchis.* (15 min.) (2×2 lantern). **H. T. Russell, Jr.,** University of California, Los Angeles, Calif.

4. Preliminary report on the life histories of a liver- and a kidney-fluke from the Ruffed Grouse in Algonquin Park, Ontario. (10 min.) (Standard and 2×2 lanterns). **N. Kingston,** Ontario Research Foundation, Toronto, Canada. (Also presented by demonstration—see Abstract #105).

5. Homologies of the clamp sclerites of *Chimaericola leptogaster* (Leuckart, 1830) Brinkman, 1942 (Chimaericoloidea: Monogenea) and related gill parasites of holocephalan fishes. (10 min.) (Standard lantern). **W. J. Hargis, Jr.,** Virginia Fisheries Laboratory, Gloucester Point, Va. (Also presented by demonstration—see Abstract #103).

[1] An alphabetical author-index will be found at the end of this section of the program. Extra copies of this supplement will be on sale at the meeting.

6. Observations on the penetration of the snail host by the miracidium of the ochetosomatid trematodes. (10 min.) (2×2 lantern). **E. E. Byrd,** University of Georgia, Athens, Ga.

7. Schistosome dermatitis at Lake Okoboji, Iowa. (10 min.) (Standard and 2×2 lanterns). **M. J. Ulmer,** Iowa State College, Ames, Iowa.

8. On the virulence of different geographic strains of *Schistosoma japonicum.* (15 min.) (2×2 lantern). **S. Y. L. Hsü** and **H. F. Hsü,** State University of Iowa, Iowa City, Iowa.

9. Additional data on the enhancement of the in vivo schistosomicidal activity of antimony compounds by glycerol. (15 min.) (Standard and 2×2 lanterns). **G. W. Luttermoser,** National Institutes of Health, Bethesda, Md.

10. In vitro cultivation of the sparganum of *Spirometra mansonoides* to the infective stage. (9 min.) (Standard lantern). **J. F. Mueller,** State University of New York, Upstate Medical Center, Syracuse, N. Y.

11. Influence of host nutritional level on the growth rate of *Sparganum mansonoides.* (6 min.) (Standard lantern). **J. F. Mueller, J. Tepperman,** and **R. Q. Tener,** State University of New York, Upstate Medical Center, Syracuse, N. Y.

12. The body, hooks and parenchyma of a dilepidid oncosphere. (15 min.) (2×2 lantern). **R. E. Ogren,** Dickinson College, Carlisle, Pa.

13. Growth of the spiny-headed worm, *Moniliformis dubius,* and the rat tapeworm, *Hymenolepis diminuta,* in concurrent infections in rats. (10 min.) **J. C. Holmes,** Rice Institute, Houston, Tex.

14. Rate of development of acquired immunity in mice to egg infections with *Hymenolepis nana* var. *fraterna.* (5 min.) (Standard lantern). **C. J. Weinmann,** University of California, Berkeley, Calif.

15. Egg-production by *Hymenolepis nana* var. *fraterna* and egg infectivity after passage from mice with light, moderate, and heavy worm burdens. (5 min.) (Standard lantern). **C. J. Weinmann,** University of California, Berkeley, Calif.

16. Sensitivity of developing *Hymenolepis diminuta* larvae to high temperature stress. (10 min.) (Standard lantern). **M. Voge,** University of California, Los Angeles, Calif.

Read by Title Only

17. A system for the laboratory propagation of *Spirometra mansonoides.* **J. F. Mueller,** State University of New York, Upstate Medical Center, Syracuse, N. Y.

18. The use of purified antigens in the immunodiagnosis of schistosomiasis. **E. H. Sadun, B. C. Walton,** and **A. Yamaki,** 406th Medical General Laboratory, Japan, APO 343, San Francisco, Calif.

19. The use of purified antigens in the immunodiagnosis of paragonimiasis in humans and experimental animals. **E. H. Sadun, A. A. Buck,** and **B. C. Walton,** 406th Medical General Laboratory, Japan, APO 343, San Francisco, Calif., and German Red Cross Hospital, Pusan, Korea.

20. On a new first intermediate host, *Paludinella devilis* (Gould, 1861) Habe, 1942, of *Paragonimus ohirai* Miyazaki, 1939. **M. Yokogawa,** Chiba University, Chiba, Japan.

21. Immunological reactions in paragonimiasis. **M. Yokogawa,** Chiba University, Chiba, Japan.

22. The use of naked snails in the study of larval trematode infections. **L. R. Penner,** University of Connecticut, Storrs, Conn., Archbold Biological Station, Lake Placid, Florida, and Cape Haze Marine Laboratory, Placida, Florida.

23. Observations on *Melania maulensis* as intermediate host of *Stellantchasmus falcatus* in Hawaii. **K. Noda,** University of Hawaii, Honolulu.

24. Preliminary winter survival studies 1956–1957, 1957–1958 on *Stagnicola palustris nuttalliana* (Lea, 1841) and *Physa propinqua* Tryon, 1865. **C. W. McNeil** and **W. M. Walter,** State College of Washington, Pullman, Wash.

25. Comparative vitamin studies on *Helisoma trivolis* and *Littorina litorea.* **R. M. Coleman,** Russell Sage College, Troy, N. Y.

Monday Afternoon Session, August 25, 2:00 P.M.
University School Auditorium

Paul C. Beaver, Tulane University, PRESIDING

Read

26. Application of the Peterson technique of cecal cannulation to chemotherapeutic studies. (10 min.) (2×2 lantern). **L. H. Saxe** and **G. F. Fisher,** W.V.U. Medical Center, Morgantown, W. Va.

27. Experimental study in guinea pigs of the pathogenicity of *Entamoeba histolytica* from infected persons in Ward Siloé, Cali, Colombia. (10 min.) **I. M. Krupp** and **E. C. Faust,** Tulane University, New Orleans, La. and University of Valle, Cali, Colombia.

28. Some pharmacological aspects of a toxic substance found in the oocyst of the coccidian, *Eimeria tenella.* (15 min.) (Standard and 2×2 lanterns). **M. T. Rikimaru** and **F. T. Galysh,** North Dakota Agriculture College, Fargo, N. D., and **R. F. Shumard,** Eli Lilly Agricultural Research Division, Indianapolis, Ind.

29. The effect of low and high temperatures on the sporulation and viability of *Eimeria labbeana* oocysts. (10 min.) (Standard lantern). **S. Duncan,** Boston University, Boston, Mass.

30. Differences in 2 strains of *Trichomonas vaginalis* as revealed by intraperitoneal injections into 6 strains of mice. (10 min.) (Standard lantern). **Lucy V. Reardon** and **L. Jacobs** (with technical assistance of **V. E. Davis**), National Institutes of Health, Bethesda, Md.

31. Host-parasite relations in trichomoniasis. The immune response in mice infected with *Trichomonas gallinae* (Rivolta, 1878) Stabler, 1938. (15 min.) (2×2 lantern). **L. G. Warren** and **A. C. Chandler,** Rice Institute, Houston, Texas.

32. Growth and development of *Crithidia* sp. in avian embryos incubated at 30° and 37° C. (15 min.). **R. B. McGhee,** University of Georgia, Athens, Ga.

33. Enhanced virulence of a strain of *Plasmodium lophurae* following prolonged serial passage in chicks. (10 min.) (2×2 lantern). **R. W. Hull,** Northwestern University, Evanston, Ill.

34. In vitro development of the mosquito phase of *Plasmodium relictum.* (15 min.) (2×2 lantern). **G. H. Ball** and **J. C. Chao,** University of California, Los Angeles, Calif.

35. Free amino acid content of the adult tropical rat mite, *Ornithonyssus bacoti* (Hirst, 1913). (10 min.) (Standard lantern). **E. A. Zein-Eldin** and **J. A. Scott,** University of Texas Medical Branch, Galveston, Texas. (Also presented by demonstration—see Abstract #111).

36. A study of some ecological factors influencing acarine populations of Egyptian gerbils' burrows. (10 min.) (Standard and 2×2 lanterns). **C. E. Yunker,** University of Maryland, College Park, Md.

37. Additions to the tick fauna of Indiana (Acarina: Argasidae, Ixodidae). (10 min.). **N. Wilson,** Purdue University, West Lafayette, Ind.

38. The variation in laboratory-bred ticks. (15 min.) (Standard lantern). **B. Feldman-Muhsam** and **J. Kahn,** Hebrew University, Israel.

Read by Title Only

39. Capacity of different strains of *Entamoeba histolytica* from infected persons in Ward Siloé, Cali, Colombia to ingest and digest starches consumed by the human hosts. **T. R. Read,** Tulane University, New Orleans, La., and **E. C. Faust,** Tulane University and University of Valle, Cali, Colombia.

40. Effect of sodium ricineoleate on *Entamoeba histolytica.* **M. Nakamura** and **P. R. Edwards, Jr.,** Montana State University, Missoula, Mont.

41. Studies on the age resistance offered by rats, guinea pigs and cats against *Trypanosoma evansi* infection. **L. M. Yutuc,** University of Philippines, Diliman-Quezon, Philippines.

42. The blood protozoa of the marine fish of Southern New England. **W. L. Bullock,** University of New Hampshire, Durham, N. H.

Tuesday Morning Session, August 26, 9:00 A.M.
University School Auditorium

Aurel O. Foster, USDA, PRESIDING

Read

43. Relation of *Escherichia coli* to the development of the preparasitic stages of various cattle nematodes. (15 min.) (Standard lantern). **H. Ciordia** and **W. E. Bizzell,** Agricultural Research Service, USDA, Experiment, Ga.

44. Parasites in a selected group of swine in Alabama. (10 min.) (Standard lantern). **E. Lesser** and **C. D. Squiers,** Agricultural Research Service, USDA, and Alabama Agricultural Experiment Station, Auburn, Ala.

45. The relation of two weekly pasture rotation systems to the acquisition of gastrointestinal nematodes by sheep. (10 min.) (2×2 lantern). **N. D. Levine, R. E. Bradley,** and **R. M. Mack,** University of Illinois, Urbana, Ill.

46. Experimental cross-transmission of two strains of *Haemonchus* from wild ruminants to domestic sheep, with observations on their pathogenicity as compared with *Haemonchus* from domestic sheep. (10 min.). **R. W. Allen, G. A. Schad,** and **K. S. Samson,** ARS, USDA, State College, N. M.

47. Observations on early development of *Ascaridia columbae* in the pigeon. (15 min.) (Standard and 2×2 lanterns). **J. C. Hwang** and **E. E. Wehr,** USDA, Beltsville, Md.

48. Studies on "self-cure" and acquired resistance to *Heterakis* infections in chickens and turkeys. (10 min.) (2×2 lantern). **E. E. Lund,** ARS, Parasite Station, Beltsville, Md.

49. The life history and development of *Toxascaris leonina* (von Linstow 1902) in the dog and cat. (10 min.). **J. F. A. Sprent,** University of Queensland Veterinary School, Brisbane, Queensland, Australia.

50. Blood and plasma volume, total serum protein, and electrophoretic serum fractionation of calves experimentally infected with *Trichostrongylus axei.* (15 min.) (Standard, 3¼ × 4 in., and 2×2 lanterns). **S. E. Leland, Jr., J. H. Drudge,** and **Z. N. Wyant,** Kentucky Agricultural Experiment Station, Lexington, Ky.

51. Larval migration and accompanying pathological changes in experimental ovine strongyloidiasis. (10 min.) (Standard and 2×2 lanterns). **J. H. Turner** and **W. T. Shalkop,** ARS, USDA, Beltsville, Md.

52. Observations on the association of esophageal sarcomas with *Spirocerca lupi* infection in the dog. (10 min.) (2×2 lantern). **W. S. Bailey** and **W. E. Ribelin,** Alabama Polytechnic Institute, Auburn, Ala.

53. The morphogenesis of the parasitic stages of the cattle lungworm, *Dictyocaulus viviparus,* in experimentally infected guinea pigs. (10 min.) (2×2 lantern). **F. W. Douvres** and **J. T. Lucker,** USDA, ARS, Beltsville, Md.

54. The incidence of helminth lung parasites of *Lynx rufus rufus* (Shreber) and the life cycle of *Anafilaroides rostratus* Gerichter, 1949. (10 min.) (2×2 lantern). **H. L. Klewer,** Virginia Polytechnic Institute, Blacksburg, Va.

55. Observations on swine experimentally infected with the kidney worm, *Stephanurus dentatus.* (10 min.) (2×2 lantern). **F. G. Tromba,** ARS, USDA, Beltsville, Md.

56. Vital staining of blood parasites with acridine orange. (10 min.) (Standard and 2×2 lanterns). **N. Rothstein,** Walter Reed Army Institute of Research, Washington, D. C.

Read by Title Only

57. Observations on the development of *Cooperia punctata* of cattle in rabbits. **J. E. Alicata,** University of Hawaii, Honolulu.

58. Preliminary report on helminths of beef cattle in Arizona. **L. W. Dewhirst, R. J. Trautman,** and **W. J. Pistor,** University of Arizona, Tucson, Ariz.

59. Occurrence of *Onchocerca armillata* Railliet and Henry, 1909, in Sudanese cattle, *Bos indicus.* **E. Abdel Malek,** University of Khartoum, Sudan, Africa.

60. Life cycle studies on the nematode *Subulura brumpti* (Lopez-Neyra, 1922) Cram, 1926, and its distribution in the Sudan. **E. Abdel Malek,** University of Khartoum, Sudan, Africa.

61. Further effects of altered gas tensions on activity of plant-parasitic nematodes. **J. Feldmesser, W. A. Feder,** and **R. V. Rebois,** U.S. Dept. of Agriculture, Orlando, Fla.

Tuesday Afternoon Session, August 26, 2:00 P.M.
University School Auditorium

Francis J. Kruidenier, University of Illinois, PRESIDING

Read

62. Trehalose and glucose in helminths and other invertebrates. (15 min.)

(2×2 lantern). **D. Fairbairn,** McGill University, Macdonald College, Quebec, Canada.

63. The effect of stilbestrol implants upon the development of *Trichostrongylus axei* and *T. colubriformis* in the laboratory rabbit. (10 min.) (Standard lantern). **G. H. Rohrbacher, Jr.,** ARS, USDA, Auburn, Ala.

64. Dilution egg counts of *Nematospiroides dubius* in mice and rats. (10 min.) (Standard lantern). **J. H. Cross, Jr., C. Dawson, J. A. Scott,** and **E. M. Macdonald,** University of Texas Medical Branch, Galveston, Texas. (Also presented by demonstration—see Abstract #98).

65. Preliminary studies on *Nematospiroides dubius* (Baylis, 1926). (10 min.) (2×2 lantern). **G. Y. H. Liu** and **M. H. Ivey,** University of Missouri, Columbia, Mo.

66. *Aspiculuris* (Nematoda: Oxyuridae) from the wood rats of the Grand Canyon National Park, Arizona. (10 min.) (2×2 lantern). **F. J. Kruidenier** and **K. N. Mehra,** University of Illinois, Urbana, Ill.

67. On the epizootiology of *Capillaria hepatica* (Bancroft, 1893) in Algonquin Park, Ontario. (10 min.) (Standard and 2×2 lanterns). **R. S. Freeman,** Ontario Research Foundation, Toronto, Canada.

68. Studies on parasites of fishes in South Dakota. (15 min.) (2×2 lantern). **E. J. Hugghins,** South Dakota State College, Brookings, S. D.

69. A microfilaria from the Gila monster. (10 min.) (Standard lantern). **R. M. Stabler** and **S. M. Schmittner,** Colorado College, Colorado Springs, Colo. and University of Georgia, Athens, Ga.

70. The extraction and analysis of the nucleic acids of *T. spiralis* larvae. (10 min.). **E. Goldberg,** State University of Iowa, Iowa City, Iowa.

71. Observations on the oral transplantation of intestinal stages of *Trichinella spiralis.* (10 min.) (Standard lantern). **F. F. Katz,** Jefferson Medical College, Philadelphia, Pa.

72. Studies on fecal transmission of *Trichinella spiralis.* (10 min.) (Standard lantern). **W. J. Zimmermann, E. D. Hubbard,** and **J. Mathews,** Iowa State College, Ames, Iowa.

73. The role of rats and mice in transmitting *Trichinella* through their feces. (15 min.) (Standard and 2×2 lanterns). **O. W. Olsen** and **H. A. Robinson,** Colorado State University, Fort Collins, Colo.

74. Thelaziasis in California, with a report on reservoir hosts. (10 min.) (16 mm. motion picture projector). **E. D. Wagner** and **H. S. Burnett,** College of Medical Evangelists, Loma Linda, Calif.

75. An autogenous strain of *Culex tarsalis* Coq. (10 min.) (Standard lantern). **J. Chao,** University of California, Los Angeles, Calif.

76. Studies on the defense mechanism of the oyster, *Crassostrea virginica.* (10 min.). **M. R. Tripp,** Rutgers, the State University of New Jersey, New Brunswick, N. J.

Read by Title Only

77. Age and infectivity of the filariform larvae of the rat nematode *Nippostrongylus muris.* **A. J. Haley** and **C. M. Clifford,** University of Maryland, College Park, Md.

78. Phototactic and thermotactic responses of filariform larvae of the rat

nematode *Nippostrongylus muris* (Yokagawa, 1920). **J. C. Parker** and **A. J. Haley,** University of Maryland, College Park, Md.

79. Experimental *Trichinella spiralis* infections in hibernating hamsters. **R. M. Chute** and **S. Lewis,** Middlebury College, Middlebury, Vt.

80. Experimental *Trichinella spiralis* infections in bats. **R. M. Chute** and **D. B. Covalt,** Middlebury College, Middlebury, Vt.

81. The survival of challenging *Litomosoides carinii* larvae in immature and mature white rats as influenced by cortisone. **L. J. Olson,** University of Texas Medical Branch, Galveston, Texas.

Wednesday Morning Session, August 27, 9:00 A.M.
University School Auditorium

Raymond M. Cable, Purdue University, PRESIDING

Read

82. Experimental low-level and single-dose sulfonamide treatment of bovine coccidiosis. (10 min.) (Standard and 2×2 lanterns). **D. M. Hammond, G. W. Clark, M. L. Miner, W. A. Trost,** and **A. E. Johnson,** Utah State University, Logan, Utah and ARS, USDA, Logan, Utah.

83. Some experiences with the use of *Syphacia obvelata* as a test organism for detecting anthelmintic activity. (10 min.) (Standard lantern). **J. E. Lynch** and **E. E. Hoegl,** Pfizer Therapeutic Institute, Maywood, N. J.

84. Compound 1871. A new anthelmintic. I. Preliminary studies on the therapeutic activity against *Nematospiroides dubius.* (10 min.) (Standard lantern). **J. E. Lynch** and **B. J. Visentin,** Pfizer Therapeutic Institute, Maywood, N. J.

85. Results from a one-year field trial on the effects of N-phenyl-N^1-dichloroacetylpiperazine daily in the feed on natural *Ancylostoma caninum* infections in dogs. (10 min.) (Standard lantern). **W. Wallace, J. Emro,** and **D. W. Johnson,** American Cyanamid Company, Pearl River, N. Y.

86. A new anthelmintic effective against *Ancylostoma caninum.* (10 min.) (Standard lantern). **R. B. Burrows,** Burroughs Wellcome & Co., Tuckahoe, N. Y.

87. Dithiazanine iodide, an effective broad-spectrum anthelmintic for small animals. (10 min.) (Standard lantern). **M. C. McCowen, M. E. Callender, M. C. Brandt, F. O. Gossett, R. P. Gregory,** and **R. F. Shumard,** Lilly Research Laboratories, Indianapolis, Ind.

88. The anthelmintic activity of piperazine dihydrochloride monohydrate in the chicken's diet against *Ascaridia galli* larvae. (10 min.) (Standard lantern). **S. Kantor, A. Bliznick,** and **R. L. Kennett, Jr.,** American Cyanamid Company, Pearl River, N. Y.

89. Swine nematode control in Puerto Rico. (5 min.). **C. R. Peebles** and **J. D. Rivera-Anaya,** University of Puerto Rico Agricultural Experiment Station, Rio Piedras, Puerto Rico.

90. The effects of ½ gram of phenothiazine on the development of infective larvae of *Cooperia punctata* in pure infections in cattle. (15 min.) (2×2 lantern).

R. L. Mayhew, B. G. Torbert, and **G. C. Miller,** Louisiana State University, Baton Rouge, La.

91. Observations on the resistance of a strain of *Haemonchus contortus* to single therapeutic doses of phenothiazine. (10 min.) (Standard lantern). **J. H. Drudge, S. E. Leland, Jr., Z. N. Wyant,** and **G. W. Elam,** University of Kentucky, Lexington, Ky.

Read by Title Only

92. An analysis of the fluctuation of hookworm egg counts of puppies in a screening program. **R. Thorson** and **J. Pankavich,** American Cyanamid Company, Pearl River, N. Y.

93. Immunity to *Cooperia punctata* in pure infections in cattle. **R. L. Mayhew, B. G. Torbert,** and **G. C. Miller,** Louisiana State University, Baton Rouge, La.

PRESIDENTIAL ADDRESS, AMERICAN SOCIETY OF PARASITOLOGISTS
11:15 A.M.

94. Some parasites and their chromosomes. **A. C. Walton,** Knox College, Galesburg, Ill.

Wednesday Noon, August 27, 12:15 P.M.
Alumni Hall

Annual Luncheon and Business Meeting of the Society
Arthur C. Walton, PRESIDING

(Get tickets at time of registration)

Wednesday Afternoon Session, August 27, 2:30 P.M.
Rooms 101, 105, and 107, Jordan Hall

Shelby D. Gerking, In Charge
(Laboratories will be open all Wednesday morning for setting up demonstrations.)

All Papers by Demonstration and Exhibit

95. A species of *Nosema* (Sporozoa: Microsporidia) parasitic in the flour beetle, *Tribolium confusum.* **A. F. West,** Purdue University, Lafayette, Ind.

96. *Sarcocystis* in certain birds. **G. M. Clark,** Patuxent Research Refuge, Laurel, Md.

97. Observations on the time and number of molts in the intestinal phase of *Trichinella spiralis.* **J. B. Villella,** University of Michigan, Ann Arbor, Mich.

98. Dilution egg counts of *Nematospiroides dubius* in mice and rats. **J. H. Cross, Jr., C. Dawson, J. A. Scott,** and **E. M. Macdonald,** University of Texas Medical Branch, Galveston, Texas. (See Abstract #64).

99. Guinea worms in a raccoon from South Dakota and in mink from Minnesota. **E. J. Hugghins,** South Dakota State College, Brookings, S. D.

100. Studies on *Philonema agubernaculum,* a dracunculoid nematode infecting salmonids. **M. C. Meyer,** University of Maine, Orono, Me.

101. Ultrastructure at the surface of cercariae of *S. mansoni* and of a plagiorchioid (*Tetrapapillatrema concavocorpa* ?). **F. J. Kruidenier** and **A. E. Vatter,** University of Illinois, Urbana, Ill.

102. Systematic position of the genus *Dihemistephanus* (Trematoda: Digenea). **L. E. Peters,** Purdue University, West Lafayette, Ind.

103. Homologies of the clamp sclerites of *Chimaericola leptogaster* (Leuckart, 1830) Brinkmann, 1942 (Chimaericoloidea: Monogenea) and related gill parasites of holocephalian fishes. **W. J. Hargis, Jr.,** Virginia Fisheries Laboratory, Gloucester Point, Va. (See Abstract #5).

104. Studies on the life history of *Mosesia chordeilesia* McMullen 1936 (Trematoda: Lecithodendriidae). **J. E. Hall,** Purdue University, Lafayette, Ind.

105. Preliminary report on the life histories of a liver and kidney fluke from the ruffed grouse in Algonquin Park, Ontario. **N. Kingston,** Ontario Research Foundation, Toronto, Canada. (See Abstract #4).

106. Some trematodes of the genus *Hasstilesia* from unusual hosts. **E. J. Robinson, Jr.,** Kenyon College, Gambier, Ohio.

107. A new strigeid trematode (Diplostomatidae: Alariinae) from the pancreatic duct of the raccoon. **R. Harkema** and **G. C. Miller,** North Carolina State College, Raleigh, N. C.

108. Some trematodes from Turkey and Egypt. **W. H. Coil** and **R. E. Kuntz,** University of Nebraska, Lincoln, Neb.

109. Effects of colchicine on *Hymenolepis nana.* **F. J. Etges** and **M. J. Sirkin,** University of Cincinnati, Cincinnati, Ohio.

110. Structures in the oncosphere of *Hymenolepis diminuta,* a cestode in rats. **R. E. Ogren,** Dickinson College, Carlisle, Pa.

111. Free amino acid content of the adult tropical rat mite, *Ornithonyssus bacoti* (Hirst, 1913). **E. A. Zein-Eldin** and **J. A. Scott,** University of Texas Medical Branch, Galveston, Texas. (See Abstract #35).

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ABSTRACTS

1. **Copepods Parasitic on Starfishes and Sea Urchins in Madagascar.** ARTHUR G. HUMES, Boston University.

Eight species of cyclopoid copepods were found on the body surfaces of littoral starfishes and sea urchins collected at Nossi-Bé, Madagascar. The copepods from starfishes comprise a new siphonostome family with 2 new genera and species, one from 4 oreasterids, *Protoreaster lincki, Poraster superbus, Pentaceraster mammillatus,* and *Culcita schmideliana,* the other from *Acanthaster planci. Lichomolgus oreastriphilus* (Kossmann 1877), previously known only from the Red Sea, also parasitizes the 4 oreasterids just mentioned. The copepods from sea urchins include 2 new taeniacanthid genera recovered from *Diadema setosum,* 1 genus with 2 new species, the other with 1; 2 new species of the lichomolgid genus *Pseudanthessius,* one from *Echinometra mathaei* and the other from *Stomopneustes variolaris;* and another lichomolgid from *Diadema setosum,* as yet undetermined, though closely resembling Sewall's *Preherrmannella.* Although little is known of the biology of these copepods, the siphonostomes and taeniacanthids are probably true parasites in view of their host specificity, their structural modifications, and their inability to swim freely. The lichomolgids, on the other hand, are less modified, are able to swim to some extent, and presumably may at times leave the host.

2. **A Preliminary Report on an Ecological Study of a Fish and Its Parasites.** ELMER R. NOBLE, University of California, Santa Barbara College.

The mudsucker, *Gillichthys mirabilis,* and all of its parasites are being studied as an ecological unit over a period of 3 years. The first year has been completed. Collections of fish are made several times each week and records are kept of numbers, kinds and locations of parasites; of the sex and size of host; of temperature and salinity of the water (a slough); prevailing weather and significant changes in surrounding flora and fauna. Many unidentified helminth cysts have been recovered from various organs, and occasionally new species of protozoa and worms have been noted on the gills or in the intestine, but the most common parasites are: From the gills—a monogenetic trematode (*Gyrodactylus* sp.), an adult digenetic trematode (*Hysterolecitha* sp.), and *Trichodina* sp.; from the intestine—a nematode (*Spirocamallanus* sp.), another nematode, and a larval cestode; from the bile ducts—a nematode.

Tentative conclusions, on the basis of about 300 hosts are as follows: 1. Except for the largest fish, larger hosts have more kinds of parasites than do smaller fish. 2. More fish up to about 130 mm long are infected with intestinal larval cestodes than with gill *Hysterolecitha,* but in larger fish this relation is reversed. 3. The numbers of hosts infected with certain parasites tend to fluctuate markedly each month (i.e., many during one month, fewer the next month, then many, etc.). 4. From July through December there appears to be a monthly alternation of relative abundance of larval cestodes and digenetic trematodes, but after December a constant preponderance of cestodes as compared with trematodes.

3. **A Review of the Genus** *Parorchis.* HOMER T. RUSSELL, JR., University of California, Los Angeles.

Parorchis acanthus (Nicoll) 1906, Nicoll, 1907, was described from 2 specimens found in the cloaca of a Herring Gull (*Larus argentatus*) collected in England. Nicoll, 1907, extended the description of this species on the basis of numerous specimens and extended its host range to include *Larus canus. P. avitus* Linton, 1914, was described from *Larus argentatus* collected at Woods Hole, U.S.A. Cable and Martin, 1935, and Rees, 1939, synonymized these 2 species. *P. pittacium* (Braun) 1901, from *Strepsilas interpres,* Brazil, was included in the genus by Nicoll, 1906. Linton, 1928, noted the great similarity of the above 3 trematodes. Four other species have been described: *P. proctobium* (Travassos) 1918, from *Nyctanassa violacea,* Brazil; *P. gedoelsti* (Skrjabin) 1924, from *Tringa alpina* and *Calidris arenaria,* Russia; *P. asiaticus* Strom 1927, from *Gelochelidon nilotica,* Turkestan; and *P. smipis* Lal 1936, from *Totanus hypoleucos,* India.

Eighty-eight specimens of *Parorchis* were collected from 5 species of hosts (*Catatrophorus semipalmatus, Totanus melanoleucus, Erolia minutilla, Erolia alpina,* and *Limnosa fedoa*). Thirty-two of the more mature specimens were measured and all the specimens were compared with one another and with descriptions in the literature. No taxonomically valid difference was found among the specimens. The specimens studied showed the characters used as criteria in the descriptions of the above species. *Parorchis* apparently contains only 1 species: *Parorchis pittacium* (Braun) 1901.

4. **Preliminary Report on the Life Histories of a Liver- and a Kidney-Fluke from the Ruffed Grouse in Algonquin Park, Ontario.** NEWTON KINGSTON, Ontario Research Foundation.

The life histories of 2 trematodes from the Ruffed Grouse, *Bonasa umbellus,* in Algon-

quin Park, Ontario have been studied: *Brachylecithum* sp. (Dicrocoeliidae) from the biliary ducts and *Tanaisia zarudnyi* (Eucotylidae) from the urinary tubules of the host bird.

Brachylecithum sp. will develop in 4 species of terrestrial molluscs: *Zonitoides arboreus, Cionella lubrica, Deroceras reticulatum,* and *D. laeve.* The cercariae are liberated from the molluscs in the form of slime-balls in 5–7 months, post-feeding. The role of a putative second intermediate host for this parasite is presently under investigation.

Tanaisia zarudnyi will develp in 2 species of terrestrial snails, *Succinea ovalis* and *Anguispira alternata.* Encysted cercariae are found in the tissues of the host snail at 2½ months. Final infection of the host bird following ingestion of the cysts has yet to be demonstrated.

The liver fluke is considered to be a new species belonging to the genus *Brachylecithum.* A description is appearing elsewhere.

5. **Homologies of the Clamp Sclerites of *Chimaericola leptogaster* (Leuckart, 1830) Brinkman, 1942 (Chimaericoloidea: Monogenea) and Related Gill Parasites of Holocephalan Fishes.** W. J. Hargis, Jr., Virginia Fisheries Laboratory.

Brinkmann (1952, Universitet i Bergen Arbok 1952: 1–134) concluded on the basis of similarities in internal morphology that chimaericolids are related to Hexabothriidae and Diclidophoroidae and bridge the evolutionary gap between them. Sproston (1946, Trans. Zool. Soc. London **25**: 185–600), partially concurred and inferred homology between their clamp sclerites and those of advanced diclidophoroidids. However, she explained the abbreviated sclerite condition by supposing reduction and even suggested that *Chimaericola* foreshadows the extremely reduced sclerites of Hexostomatidae. Careful examination of the clamps of 5 *C. leptogaster* specimens, kindly loaned by Dr. Brinkmann of the Bergen Museum, suggests primitiveness as a more likely explanation. The primitive internal organs support this conclusion. Accordingly, the medial separation of the main clamp sclerites of chimaericolids and most diclidophoroidids is probably primitive.

The anterior loop sclerites of chimaericolid clamps are probably homologous to those of diclidophoroidids and the posterior loop sclerites are homologues of their reduced posterior loop elements. No other author has noted the "abbreviated sclerite" of the middle, opposable loop pictured by Sproston, and our specimens had none. Sproston pointedly stated "There is no hint of a hook on the end of the median cuticularized tendon (center piece, *mihi*) which might suggest relationship with that other primitive group *Dicyclobothrium*. . . ." However, close inspection of several *Chimaericola* center pieces discloses extreme similarity to the sucker-hooks of *Dicyclobothrium,* and it is possible that these structures are homologous. Thus, the probable phylogenetic connection between hexobothriids, chimaericoloidids and diclidophoroidids is supported by both holdfast homology and internal similarity.

6. **Observations on the Penetration of the Snail Host by the Miracidium of the Ochetosomatid Trematodes.** Elon E. Byrd, University of Georgia.

The miracidium of the ochetosomatid flukes is released from the shell capsule only after the egg has been eaten by the physid snail. The cilia appear to be strong enough to permit the miracidium to swim sluggishly in the contents of the gut and to bring the miracidium into contact with the mucosal lining. Once this contact is made and penetration commences, the ciliated epidermal plates become loosened and soon they buckle away from the body. As the miracidium "slips" through its newly made opening into the tissue the several epidermal plates slide from the body and are left wedged into the opening as a cluster of crumpled, flake-like scales. The cilia still can be seen covering the outer surfaces of the individual plates. On entering the mucosa of the gut's wall the body of the miracidium rounds up and comes to lie as a thin-walled, sacculated body closely pressed against the muscularis layer of the gut. Approximately 24 to 48 hours are required for the "mother sporocyst" to dissolve her way through the muscularis into the adjacent lymph spaces. The vast majority of the miracidia penetrate into the lymph spaces which surround the central third of the small intestine's length, or exit is made from that part of the intestine which is surrounded by the distal ends of the liver lobes and the ovi-testis. In the lymph spaces the mother sporocyst develops into an elongated sac filled with large germ cells. No sporocyst has been followed beyond the 96th hour of development.

7. **Schistosome Dermatitis at Lake Okoboji, Iowa.** Martin J. Ulmer, Iowa State College.

Studies have been underway since 1954 on the molluscan hosts harboring cercariae which are responsible for increasingly severe outbreaks of "swimmers itch" at Lake Okoboji in northwest Iowa. A systematic examination of more than 3000 snails collected during the summers of 1956 and 1957 from numerous resort areas indicates that physid snails are involved.

Of 919 *Physa gyrina* Say and 642 *Physa sayii* Tappan which were examined, 2 of the latter species of snail produced cercariae of the *ocellata* group. Laboratory exposure of emerged cercariae to the forearm resulted in the charateristic cercarial dermatitis associated with certain schistosomes.

Careful morphological studies and measurements show that the emerged cercaria here involved is similar to that of *Trichobilharzia physellae* (Talbot) and *T. cameroni* Wu, except for differences in body length and tail stem length. It differs from *physellae*, too, in its swimming activities. It may be distinguished from *Cercaria epsilon* (a dermatitis-producing cercaria also from *P. sayii*) as described by Brooks (1948) by differences in measurements.

Of considerable interest has been the very low percentage of infected *Physa sayii* collected from the rocky beaches where outbreaks of dermatitis have been especially severe. (This investigation was supported in part by a grant from the National Science Foundation.)

8. **On the Virulence of Different Geographic Strains of** *Schistosoma Japonicum*. S. Y. Li Hsü and H. F. Hsü, College of Medicine, State University of Iowa, Iowa City, Iowa.

This study deals with 4 geographic strains of *Schistosoma japonicum*, viz. Chinese, Formosan, Japanese, and Philippine. For each strain, 36 albino mice were infected with 50 male and 50 female cercariae. The number of days from the infection of each mouse until its death was recorded. Then a comparison of the various strains in respect to the duration of survival was made.

9. **Further study on the Enhancement of the in vivo Schistosomicidal Activity of Antimony Compounds by Glycerol.** George W. Luttermoser, Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, Md.

Additional tests confirmed the previous finding of the enhancement of the schistosomicidal activity of tartar emetic or of stibophen in mice following the administration of either drug in glycerin instead of in water solutions. The enhancement effect has been observed when tartar emetic-glycerin was given orally and when stibophen-glycerin was injected intraperitoneally or intramuscularly. Significant increase in activity was obtained when at least a 25% glycerin solution (1.5 g glycerol/kg) was given by the same route and with the antimonial. The oral and intraperitoneal toxicity of tartar emetic and stibophen for noninfected mice and dogs did not appear to be altered by the addition of glycerin. Daily injections of 25% glycerin solutions of tartar emetic into the tail veins of mice and rats resulted in leakage and hematoma. Such difficulty was usually not experienced in intravenous injections of dogs and monkeys with tartar emetic-glycerin solutions. The effect of glycerin on the therapeutic value of the antimonials is being studied in larger animals.

A possible mechanism of this enhancement was suggested by the fact that tartar emetic was more stable in glycerin in the test-tube. It is possible that this solvent could maintain blood levels of the drug for a longer period of time. In culture, adult schistosomes tolerated 10% glycerin but this level of glycerin did not appear to enhance the activity of stibophen or tartar emetic.

10. **In Vitro Cultivation of the Sparganum of** *Spirometra mansonoides* **to the Infective Stage.** Justus F. Mueller, State University of New York, Upstate Medical Center, Syracuse, New York.

Large spargana, removed aseptically from mice, have been maintained in Mixture 199 plus 10% calf serum for periods up to 11 months, but growth is negligible. The worms gradually die from the tail end. Fresh spargana show little effect from the addition of chick embryo extract to this medium, but in old exhausted spargana it causes a rapid outgrowth or attenuation of the scolex suggestive of transformation to the adult condition, and ends in the death of the worm.

On 4 separate occasions, numerous procercoids dissected from copepods were cultured in Mixture 199 plus 10% calf serum to which fresh chick embryo extract was added to form 20% of the total volume. The procercoids grew from 0.15 mm to approximately 7 mm in 60 days. Attempts to infect kittens with these worms were inconclusive due to prompt loss of 3 of the kittens from distemper. The fourth, a sickly animal, produced aberrant eggs for a short time, but no worm was found at autopsy.

Sparganules 0.5 mm long, recovered from the body cavity of mice 5 days after infection with procercoids, grow in the same medium to a length of approximately 7 mm in 60 days. After this length is reached, there is no further increase in size of the cultured sparganum due to sloughing of the tail. When fed to cats, these miniature larvae produced normal adult worms on 5 different occasions. In view of the wide overlapping of these 2 types of cultures, and

the similarity of the larvae produced, there can be no doubt that spargana capable of maturing in the cat can be raised from the procercoid in a cell-free medium without benefit of the second intermediate host. (Supported by research grant E-1876 of the National Institutes of Health.)

11. **Influence of Host Nutritional Level on the Growth Rate of** *Sparganum mansonoides.* JUSTUS F. MUELLER, JAY TEPPERMAN, AND ROBERT Q. TENER. State University of New York, Upstate Medical Center, Syracuse, New York.

It is generally recognized that starvation of the host, such as hibernation in fishes, carnivores, rodents, etc., results in the elimination of their intestinal parasites. Less is known concerning the effect of host starvation on tissue parasites. From a collection of spargana of equal age, from experimentally infected mice, 26 worms were selected which most nearly coincided in length, and therefore presumably in growth rate. These were decapitated, and the heads, 3–5 mm in length, injected into 26 mice (av. wt. approx. 32 g), kept in individual cages. The individual daily food intake of these mice had previously been determined. After infection the mice were divided into 2 lots. Thirteen were allowed to feed ad libitum, and 13 were placed on a daily ration of ½ their previously established level.

After 6 weeks the mice were killed, weighed, the spargana recovered, measured, weighed and assayed for N. At this time the mean weight of the control mice was 41.6 g (range 38–48), while that of the underfed was 23.5 g (22–27). In both underfed and control mice the spargana grew at the rate of approximately 2 mm/day. The mean values for length, wet weight, dry weight, and N content of the spargana grown in underfed mice exceeded those for the controls by about 10%, but these differences were not considered to be statistically significant. The ratio of parasite/host (mg worm wet wt./100 grams body wt.) was 38.8 ± S.E. 2.31 for the controls, and 80.8 ± S.E. 9.46 for the underfed ($P < 0.01$). It is concluded that the growth rate of the parasite was not retarded by underfeeding of the host. (Supported by the National Institutes of Health and the American Cancer Society.)

12. **The Body, Hooks and Parenchyma of a Dilepidid Oncosphere.** R. E. OGREN, Dickinson College, Carlisle, Pa.

The morula of this tapeworm, *Dilepis undula,* was a sphere of embryonic cells resulting from cleavage. The oncosphere, the hexacanth embryo, differentiated from this group of cells by formation of cuticle, hooks, parenchyma and epidermal glands. Hooks occurred as 3 characteristic pairs. Hooks developed in oncoblasts. A medullary contractile center developed from a binucleate primordium. Muscle fibers to the hooks and parenchyma are described. It is suggested that cortical and medullary contractile systems present are antagonistic. They are regarded as homologous respectively with cortical and longitudinal systems of the metacestode.

13. **Growth of the Spiny-Headed Worm,** *Moniliformis dubius,* **and the Rat Tapeworm,** *Hymenolepis diminuta,* **in Concurrent Infections in Rats.** JOHN C. HOLMES, The Rice Institute.

The growth and distribution of *Hymenolepis diminuta* and *Moniliformis dubius* has been studied in single and double (concurrent) infections in male Holtzman rats. Groups of 35 rats each were infected with 5 *Hymenolepis,* 10 *Moniliformis,* and 5 *Hymenolepis* plus 10 *Moniliformis;* five rats from each group were examined at weekly intervals from 1 to 6 weeks, and at 8 weeks after infection.

In either single or double infections, both species became established about the middle of the intestine, later moving anteriorly, the *Hymenolepis* reaching their normal position (anterior 1/5 of the intestine) by the end of the second week, the *Moniliformis* reaching theirs (anterior 1/3) by the fourth week. In double infections, the *Hymenolepis* began moving posteriorly by the end of the fourth week, reaching the usual position occupied in double infections (middle 1/3) by the end of the fifth week.

In single infections, growth of the *Hymenolepis,* as measured by wet weight, is rapid, the weight reaching a peak at the end of 3 weeks, followed by an irregular fluctuation; in double infections the growth is retarded, reaching a significantly lower peak at the end of 3 weeks, followed by a gradual loss.

Moniliformis growth is characterized by an initial 3- to 4-week period of geometric increase followed by a rapid linear increase in weight; in double infections the growth rate in both sexes is somewhat depressed, so that by the end of the fifth week the worms are significantly lighter.

14. **Rate of Development of Acquired Immunity in Mice to Egg Infections with *Hymenolepis nana* var. *fraterna*.** CLARENCE J. WEINMANN, University of California, Berkeley.

Tests were conducted with more than 400 Heston C_3H mice 2 to 4 months old to determine the degree of acquired resistance to graded challenge egg dosages administered at various intervals after immunization with different egg dosages. The criterion of acquired resistance was the number of 93-hour cysticercoids that developed from challenge exposures.

The rate at which acquired resistance developed was dependent upon the intensity of the immunizing infection. When sufficiently intense, a marked increase in resistance was detectable within 12 hours after initial exposure. When light immunizing infections were administered, mice did not develop a comparable degree of resistance to similar challenge infections until 48–72 hours. Even with the lightest immunizing infections (average number of cysticercoids = 7.5), mice developed a strong, if not absolute, immunity to reinfection between the third and sixth days of primary infection when challenged with up to 10,000 eggs per animal.

15. **Egg-Production by *Hymenolepis nana* var. *fraterna* and Egg Infectivity after Passage from Mice with Light, Moderate, and Heavy Worm Burdens.** CLARENCE J. WEINMANN, University of California, Berkeley.

Considerable variation in egg infectivity for mice was encountered with different lots of eggs stored and treated under comparable conditions before administration. To determine if this variation was correlated with host worm burden, groups of mice were infected with eggs obtained from mice harboring average 11-day adult worm burdens of 2.5, 27 and 101. No correlation was found between worm burden and egg infectivity as measured by the percentage development of 93-hour cysticercoids from eggs administered per os.

The number of eggs passed daily by 3 groups of mice harboring average 11-day adult worm burdens of 27, 78, and 101 was followed during the major portion of the group patent periods. Data are presented showing the effects of crowding on the reproductive potential. The number of eggs produced per worm present on the 11th day was almost in inverse proportion to the worm burden. When the initial worm burden was about 4 times that in the lightest group infection, egg-production per worm was reduced to almost ¼ that of the lighter infection. When the average worm burden was 3 times larger than the lighter infection the number of eggs produced per worm was reduced about 1/3. Early worm loss under crowded conditions as well as reduction in reproductive capacity appear to be involved.

16. **Sensitivity of Developing *Hymenolepis diminuta* Larvae to High Temperature Stress.** M. VOGE, University of California, Los Angeles.

The purpose of this study was to determine if differences in sensitivity to high temperature exposure exist at different stages in the larval development of *Hymenolepis diminuta*. Larvae of H. *diminuta* growing in *Tribolium confusum* were exposed for 24 hours or longer, to 38.5° or 40° C, during different periods of their development. Results obtained showed the following: The period most sensitive to high temperature stress is that during which maximal structural differentiation and growth of the larvae occur. Effect of exposure before or after that period is minimal. Exposure during the sensitive period results in failure of scolex-withdrawal in some of the larvae and in loss of infectivity of withdrawn and structurally normal larvae. However, both withdrawn and non-withdrawn larvae appear to be alive as indicated by additional membrane growth which occurs subsequently at favorable temperatures. High temperature stress, producing loss of infectivity when applied during the sensitive period, has no effect when applied to fully developed cysticercoids.

17. **A System for the Laboratory Propagation of *Spirometra mansonoides*.** JUSTUS F. MUELLER, State University of New York, Upstate Medical Center, Syracuse, New York.

Cestodes currently used in experimental work are mainly Cyclophyllidea. Pseudophyllideans present difficulties as laboratory material because of their dependence upon wild hosts for all or part of their life cycles. For the past 2½ years work has been under way in this laboratory for the purpose of devising practical methods for the laboratory propagation of *Spirometra mansonoides*. Simple means have been perfected for the collection of massive quantities of eggs free of foreign material, and for their sterile incubation; for the hatching of massive quantities of coracidia; for the large-scale continuous propagation of the copepod in pure culture and its infection with the procercoid; and for the massive, or quantitative, infection of mice with the sparganum.

Overwhelming fatal infections (500 or more spargana) have been produced in mice. Chronic infections (150 spargana or less) have been produced resulting in animals which are

as much as 17% by weight parasites. One cat has maintained infection with a single adult worm for almost 2 years with no diminution in egg-production. Other cats have maintained 12 or more worms for over 14 months without undergoing spontaneous cure. Previous or concurrent infection with *Taenia taeniaeformis* confers strong immunity to *Spirometra*.

Of many thousands of spargana handled in the course of this work, none of the *proliferum* type has been observed, but on 1 occasion a double-headed procercoid was encountered. Some procercoids are infective for mice as early as the 7th day of development in the copepod. Sparganules are infective for cats as early as the 12th day of development in the mouse, and probably earlier. Use of a pseudophyllidean cestode in all its stages for experimental work is now entirely practical. (Supported by research grant E-1876 of the National Institutes of Health.)

18. **The Use of Purified Antigens in the Immunodiagnosis of Schistosomiasis.** Elvio H. Sadun, B. C. Walton and A. Yamaki, 406th Medical General Laboratory, Japan.

Three antigens were prepared from adult *Schistosoma japonicum:* A relatively crude ether extraction (SC), a purified acid-soluble protein fraction (SM), and a purified acid-insoluble protein fraction (SM-INS). Two hundred and six human volunteers received intradermal tests with these antigens. Of the persons with proven schistosomiasis, 99% gave positive reactions with SM, 98% with SM-INS and 95% with SC. All the positive reactions were of the immediate type and reached their peak between 10 and 20 minutes. The mean size of the wheal 15 minutes after injection was 169, 139 and 118 mm^2 respectively. None of the trematode-free persons gave positive reactions. Although occasional cross-reactions were observed with clonorchiasis and paragonimiasis patients, the wheal produced by the homologous antigen was always much larger and more distinct. Among infected individuals, there was a gradual increase in the mean size of the wheals with age. No significant differences in the degree of cutaneous reactions were observed in the two sexes.

In the complement fixation test SM-INS antigen was used. Sera from rabbits exposed to a single heavy dose of *S. japonicum* cercariae were tested at regular intervals up to 192 days following infection. Sera from uninfected controls and from the animals before they were exposed to cercariae gave negative complement fixation reactions. The sera from infected rabbits became positive approximately 30 days following exposure to cercariae and were still positive with relatively high titers at the end of the experiment. No cross reactions were observed with sera from humans or experimental animals with clonorchiasis, paragonimiasis, histoplasmosis, coccidiodomycosis and syphilis.

19. **The Use of Purified Antigens in the Immunodiagnosis of Paragonimiasis in Humans and Experimental Animals.** Elvio H. Sadun, A. A. Buck and B. C. Walton, 406th Medical General Laboratory, Japan, and German Red Cross Hospital, Pusan, Korea.

Three antigens were prepared from adult *Paragonimus westermani:* a relatively crude ether extraction (PC), a purified acid-soluble protein fraction (PM) and a purified acid-insoluble, alkaline soluble protein fraction (PM-INS).

Over 2,000 human volunteers received intradermal tests using PM as antigen. All of the persons with proven paragonimiasis gave positive reactions whereas only 1 out of 121 trematode-free controls reacted positively. Although in some cases cross reactions occurred with schistosomiasis and clonorchiasis patients, the wheal produced by the homologous antigen was always much larger and more distinct.

In the complement fixation test, best results were obtained with PM-INS antigen. Sera from cats inoculated with a single dose of metacercariae were tested at regular intervals. All sera from the animals before ingestion of the metacercariae and from uninfected controls gave negative complement fixation reactions. The sera from infected cats became positive approximately 30 days and were still positive 130 days following infection. Stool examinations showed the first appearance of eggs between 60 and 70 days following infection.

The results obtained with the complement fixation and the intradermal tests were compared in 162 individuals. Nine percent of patients with active infections gave negative C-F reaction. Conversely, none of the people with negative intradermal tests gave positive complement fixation reaction. No cross reactions were observed using this antigen in the complement fixation reaction with sera from patients having clonorchiasis, schistosomiasis, histoplasmosis, coccidiodomycosis, actinomycosis, sarcoid, syphilis, tuberculosis, leprosy and lung carcinoma.

20. **On a New First Intermediate Host, *Paludinella devilis* (Gould, 1861) Habe, 1942, of *Paragonimus ohirai* Miyazaki, 1939.** M. Yokogawa, The Chiba University.

The first intermediate Host of *Paragonimus ohirai* was determined experimentally as

Assiminea japonica V. Martens, 1877, by Ogita (1954) and Ikeda (1957). However, the natural infection of *Assiminea japonica* with the cercariae of *P. ohirai* has never been found.

The author found the natural infection of the cercariae of *P. ohirai* in *Paludinella devilis* (Gould, 1861), Habe 1942, in the endemic area of Paragonimiasis ohirai, Shimoda district, Shizuoka Prefecture, Japan.

The *Paludinella devilis* belongs to the same family, Assimineidae, as *Assiminea japonica*, but belongs to another genus, *Paludinella* Pfeiffer, 1841.

The results of the examinations of the *Paludinella devilis* and *Assiminea japonica* which were collected at the same locality are as follows: Four out of 6,082 *Paludinella devilis* were infected with the cercariae of *P. ohirai* but none of 14,167 *Assiminea japonica* was infected.

The results of experimental infections with the miracidia of *P. ohirai* in both of the snails were as follows: 10 out of 30 *Paludinella devilis* revealed the developed cercariae of *P. ohirai* but none of 33 *Assiminea japonica* was infected.

The flame cell pattern of the cercariae of *P. ohirai* was shown to be 2[(1+1+1+1+1)+(1+1+1+1+1)].

21. **Immunological Reactions in Paragonimiasis.** M. YOKOGAWA, The Chiba University.

The author studied the relation between the results of intradermal test and complement fixation tests with the same antigen prepared from adults of *P. westermani*. The sputum and stool examinations were also carried out on all these persons.

The results are as follows:

	Skin test positive*	Stools or sputum positive	Skin test doubtful	Stools or sputum positive
c.f. test positive	317	123	27	5
c.f. test negative	231	13	93	3

* 33,000 persons were examined by the skin test. The completely negative individuals are not included in the table.

The author also did c.f. tests monthly for 1 year on a patient who was given a lobular resection of a helminthic cyst from the right lung. The titer of c.f. test of this patient was 1:160 before operation, descended to 1:60 one month after operation, and became negative on the 113th day after operation. However, the intradermal test of the patient was still positive 1 year after operation.

The author concluded that (1) the intradermal test would be very useful for screening the patients for paragonimiasis in the endemic area, (2) complement fixation tests should be carried out on the people who show positive skin tests and (3) the c.f. test is also a useful method for the diagnosis of extrapulmonary paragonimiasis and for the evaluation of cure after treatment.

22. **The Use of Naked Snails in the Study of Larval Trematode Infections.** LAWRENCE R. PENNER, University of Connecticut, Archbold Biological Station, and Cape Haze Marine Laboratory.

The chance exit from its shell and resultant survival by a single specimen of *Nassarius obsoletus* having a defective columellar muscle attachment has led to a series of studies on the emergence of cercariae from the digestive glands and other parasitized snail organs. Laboratory extractions effected with vise and hammer methods using *Batillaria minima* and *Nassarius obsoletus* as available marine gastropods have increased our knowledge of how parasitic larvae leave their sites of development in their intermediate hosts. The cercariae of *Ornithobilharzia canaliculata*, for example, usually exit tail first and individually from ruptured daughter sporocysts lying near the surface of the digestive glands of naked infected *Batillaria minima* and can and do enter the water directly and singly. In the infected snail with shell, however, an accumulation of cercariae occurs, to be shed when the snail becomes active when placed from a dry state into water. Hence, periodicity is regulated by the incoming tide.

Although snails have been kept "naked" for over a month, problems of water loss (up to 80% before death) and feeding to allow continued cercarial emergence have not been adequately solved. Naked snails in antibiotic-treated water have not lived appreciably longer than when not so treated.

Cercariaeum lintoni-infected *Nassarius obsoletus* appear to have longer naked survival than naked negative snails. Data also indicate verification that *C. lintoni* is associated with reduced penial size in *Nassarius* but no such effect has been noted in infections with *Cercaria variglandis*.

(This investigation was supported in part by research grant E-740 from the National Institutes of Health, Public Health Service).

23. **Observation on *Melania mauiensis* as Intermediate Host of *Stellantchasmus falcatus* in Hawaii.** KAORU NODA, University of Hawaii.

In connection with life history studies on the heterophyid *S. falcatus* in Hawaii, 2 species of snails, *Melania mauiensis* Lea and *M. indefinata* Lea were collected from a brackish water pond (near Haleiwa, Oahu) wherein most mullet (*Mugil cephalus*) were found naturally infected with metacercariae of this fluke. From these snails, pleurolophocercous cercariae were found to emerge from *M. mauiensis* but none from *M. indefinata*. The cercariae were exposed for about 2 hours to six young, 1-inch long, mullets which had been netted in the ocean in the vicinity of Honolulu. (An examination of 25 other similar mullets of the same group had been found to be free of metacercariae.) Fifteen days later all the mullets contained encysted metacercariae; the fish flesh was then fed to a laboratory-raised rat. At autopsy, 36 hours later, juvenile *S. falcatus* were recovered.

Natural infection with pleurolophocercous cercariae has been found in *M. mauiensis* in 49 (12.3%) out of 398 snails examined from the above-mentioned pond. No cercariae have been found in 50 *M. indefinata* examined. *M. indefinata* were not as common in the pond as *M. mauiensis*. (Supported by grant E-1647 from the National Institutes of Health, USPHS.)

24. **Preliminary Winter Survival Studies 1956–1957, 1957–1958 on *Stagnicola palustris nuttalliana* (Lea, 1841) and *Physa propinqua* Tryon, 1865.** C. W. MCNEIL AND W. M. WALTER, Department of Zoology, State College of Washington, Pullman, Washington.

Snail survival studies were conducted in Pullman during 2 winters, the first of which was colder than average, the second, milder. From November 1956 to March 1957, temperatures averaged 31° F, 2° below the long-term average, and 7° under the average temperature for the same months of 1957–1958. In November 1956, 100 each *S. palustris nuttalliana* and *P. propinqua* were placed on a roof in a metal tank containing 4 inches of water and a sloping gravel bottom. No *P. propinqua* and 25 *S. palustris nuttalliana* survived to March 1957. 100 *S. palustris nuttalliana* and 107 *P. propinqua* were placed in tanks in the same location; 34 of the former species and 40 of the latter survived to March 1958.

Field observations during the spring of 1957 before water returned to the irrigation canals showed that except for one atypical locality the survival of *S. palustris nuttalliana* was far greater than for *P. propinqua*. However, in the milder winter following, survival of *P. propinqua* was conspicuously greater than for the preceding winter. In contrast, *S. palustris nuttalliana* was not found in some canals where it had wintered successfully the year before.

During 3 successive winters the survival rates of *S. palustris nuttalliana* under varied conditions were similar. In the first, 34% of a random sample, collected from exposed surfaces of empty irrigation canals in the spring, had survived (McNeil and Walter, 1957, J. Parasitol. **43**: 114–115). Under experimental conditions during the next 2 winters, 25% and 34% survived, respectively. (This investigation was supported by grant E900C2 from the National Institute of Allergy and Infectious Diseases, U. S. Public Health Service.)

25. **Comparative Vitamin Studies on *Helisoma trivolis* and *Littorina litorea*.** R. M. COLEMAN, Russell Sage College.

Vitamin studies have not been conducted on any snail which serves as an intermediate host. In the one gastropod, *Busycon canaliculatum*, that has been studied, Fraenkel (1954) reported the presence of carnitine.

Comparative quantitative determinations were conducted on entire snail extracts from *Helisoma trivolis* and *Littorina litorea*, a vector of *Cryptocotyle lingua*, for the presence of ascorbic acid, niacin, thiamine, and biotin. Ascorbic acid was determined chemically, essentially according to the method of Robinson and Stotz (1945) and niacin, thiamine and biotin were determined microbiologically, using lactobacilli (U. S. Pharmacopeia XIV).

Ascorbic acid, niacin, and thiamine were found in both species. However, biotin (trace) was detected only in *Littorina*. Comparatively, *Littorina* contained greater concentrations of ascorbic acid (316 micrograms/g fresh substance) and niacin (32 micrograms/g fresh substance) than *Helisoma* (44 and 9 micrograms/g fresh substance respectively). Differences in thiamine content were not significant.

Preliminary studies indicate that it may be of interest to investigate other forms (e.g. *Australorbis glabratus*) comparatively since there may be great nutritional demands on a snail serving as an intermediate host to actively growing and reproducing helminths whereby some insight might be gained concerning vector specificity.

(This investigation was supported by research grant E-1609 from the National Institutes of Health, Public Health Service).

26. **Application of the Peterson Technique of Cecal Cannulation to Chemotherapeutic Studies.** L. H. SAXE AND GILBERT F. FISHER, Department of Pharmacology, West Virginia University Medical Center.

The Peterson teflon cannula (Exp. Parasit. **5**: 427–434, 1956) permits sampling of the cecal contents of rats before, during and after treatment with chemotherapeutic agents. Diluted samples are placed in a hemocytometer and protozoa are counted to evaluate population changes quantitatively. Weights, determined on an analytical balance, are used to calculate the number of organisms per 100 mg of cecal contents. The following are representative of results which will be presented. A single dose of carbarsone (100 mg/kg, orally) has, on the average, effected a reduction of over 90% in the fauna. Carbarsone (10 mg/kg, orally) given daily for 10 days has reduced the fauna by as much as 80%. Glycobiarsol (200 mg/kg, single dose, orally) has reduced populations of cecal protozoa in a manner comparable to carbarsone. Biallylamicol (100 mg/kg, single dose, orally) in some hosts has reduced the cecal population by 50% or more but in other cases has not significantly altered the fauna. (Supported by Grant E-1139, Natl. Insts. of Health, P.H.S. and Grant 214, Com. on Res., Am. Med. Assoc.).

27. **Experimental Study in Guinea Pigs of the Pathogenicity of *Entamoeba histolytica* from Infected Persons in Ward Siloé, Cali, Colombia.** IRIS M. KRUPP, Tulane University, New Orleans, Louisiana, AND ERNEST CARROLL FAUST, Tulane University and University of Valle, Cali, Colombia (International Cooperation Administration, Mutual Security Program of the United States Operational Mission to Colombia).

Young guinea pigs were employed to test the capacity of strains of *Entamoeba histolytica*, obtained as cysts from formed or semiformed feces of persons in Siloé, an unsanitated ward of Cali, Colombia, to colonize and invade the cecal wall of these animals.

Concentrates of washed cysts from 6 strains, in the amount of 10,000 to 200,000, were fed to each of 38 guinea pigs in groups of 4 to 7 per series. Seven to 10 days later the animals were sacrificed. Colonization has occurred in 7 (19.4%), and in one, possibly a second animal, mucosal invasion of the cecum had been initiated.

Trophozoites derived from cysts of 10 strains planted in Balamuth's medium were inoculated intracecally in the amount of 40,000 to 200,000, into each of 115 guinea pigs in 16 series, 4 to 15 animals per series. At autopsy of 103 animals 2 to 11 days later, colonization had occurred in 64 (62.1%), and in 54 (52.4%) tissue invasion was demonstrated, varying in surface area from small solitary lesions of the cecal wall to extensive confluent involvement of the cecum, occasionally of the adjacent colon and once of the terminal segment of the ileum, and in depth from superficial erosion of the mucosa to deeper penetration, in one animal as far as the muscular layers. Pseudodiphtheritic membranes were observed in fulminating cases.

Although all but one of these strains were of the large race, the infected persons from whom they were obtained were clinically asymptomatic. Nevertheless the experimental study demonstrated the high potency of these strains to invade the intestinal wall of these animals (82% of those in which colonies had become established).

28. **Some Pharmacological Aspects of a Toxic Substance Found in the Oocyst of the Coccidian, *Eimeria tenella*.** M. T. RIKIMARU, F. T. GALYSH, AND R. F. SHUMARD, North Dakota Agriculture College, and Eli Lilly Agricultural Research Division.

A toxic substance(s) was removed from the oocysts of a coccidian, *Eimeria tenella*. Upon intravenous injection into rabbits death invariably occurred. Pharmacological investigations and evaluations of events occurring during and terminating from this toxic manifestation, were conducted in order to determine the possible etiological factors involved in the induced pathogenesis.

The following events were observed: Hyperthermia, irregularities in the blood pressure, abnormalities of the electrocardiographic tracings, hyperglycemia followed by hypoglycemia, and a significant increase in the rate of oxygen uptake of isolated rabbit brain tissue.

There appeared to be a good correlation of events, which indicated that increased cellular metabolism was possibly the primary etiological factor which produced the various symptoms and death.

29. **The Effect of Low and High Temperatures on the Sporulation and Viability of *Eimeria labbeana* Oocysts.** STEWART DUNCAN, Boston University.

Oocysts of the pigeon coccidium, *E. labbeana*, which had been exposed to a temperature

of 0° C to 2.5° C for from 5 to 60 days did not sporulate. Such a low temperature did not kill these oocysts quickly, since they sporulated normally upon return to room temperature (20–28° C) following periods of up to 30 days at 0° C to 2.5° C, and were used to infect coccidia-free pigeons. Sixty-day samples showed no sporulation after return to room temperature. After being at a temperature of 3° to 4° C for as long as 60 days, some oocysts remained alive and sporulated at room temperature, although the percentage of sporulation was somewhat reduced.

Oocysts were kept at higher temperatures for varying lengths of time. At 30° C and 32° C the percentage of sporulation was less than that at room temperature, and at 35° C only a few oocysts sporulated. At 37° C and at higher temperatures no sporulation occurred. After oocysts had been exposed to a temperature of 35° C for 3 days and then returned to room temperature, none sporulated. A temperature of 37° C apparently killed all the oocysts within 2 days since none sporulated following return to room temperature. The high temperature of the pigeon may be a factor in preventing sporulation of *E. labbeana* oocysts within the host. The optimal temperature range for sporulation of *E. labbeana* oocysts appears to be 20 to 26° C.

30. **Differences in 2 strains of *Trichomonas vaginalis* as Revealed by Intraperitoneal Injections into 6 Strains of Mice.** Lucy V. Reardon and Leon Jacobs (with the technical assistance of Violet E. Davis), National Institutes of Health.

Recent reports have indicated susceptibility of mice to inoculation with *Trichomonas vaginalis*. Iwai (Jap. J. Parasitol. 1957. 6: 136–144) reported abscesses containing the parasites subcutis or in the peritoneal or pleural cavities depending on the method of injection: Honigberg and Braunthal [1957, J. Parasitol. 43(Suppl.): 40] evaluated strains of trichomonads by size of subcutaneous abscesses. In the present study strains of *T. vaginalis* were tested by intraperitoneal injections into mice to reveal possible differences. Two strains of parasites were used. One (C_1) was derived from a severe case of vaginitis and the other (R) from a relatively mild infection. Intraperitoneal inoculation of 1×10^6 organisms or higher of C_1 strain in pure culture regularly produced death in 6 strains of mice (A/LN, C57, BL/6JN, A/HeN, C_3/Hp, CFW/N, and GP. R strain parasites in parallel experiments did not result in death. Only slight differences were observed in susceptibility of the mouse strains to C_1 parasites. The nature of the pathologic effects produced will be described.

31. **Host-Parasite Relations in Trichomoniasis. The Immune Response in Mice Infected with *Trichomonas gallinae* (Rivolta, 1878) Stabler, 1938.** Lionel G. Warren and Asa C. Chandler, Rice Institute, Houston, Texas.

In preliminary experiments successful immunization of white mice has been achieved with metabolic antigen collected from in vitro protein-free cultures of *Trichomonas gallinae* (strain: Jones-Barnes). Complete protection was observed in 50% of the challenged animals. The remainder of the immunized group showed varying degrees of protection as evidenced by the time required for appearance of lesions, and size of lesions when compared with normal controls. Pooled sera from convalescent animals agglutinated washed suspensions of *T. gallinae* grown in vitro. Agglutination was observed in dilutions as high as 1:320. Normal mouse serum was without effect on washed *T. gallinae* suspensions. Electrophoretic studies on convalescent and normal mouse sera revealed a lowered serum protein level in convalescent sera. Albumin/gamma globulin ratios are lowered in sera with high agglutinating titres.

(This investigation was supported by a research grant (E-1384) from the National Institutes of Health, U.S.P.H.S.)

32. **Growth and Development of *Crithidia* sp. in Avian Embryos Incubated at 30° and 37° C.** R. Barclay McGhee, The University of Georgia.

The zoomastiginid, *Crithidia* sp., from *Euryophthalmus davisi* develops and, from a qualitative standpoint, reproduces on and in the cells of chorioallantoic membranes of chick embryos incubated at 30° C. The presence of parasites in the chorio-allantoic fluid and subsequent inoculation into the cavity made possible quantitative measurements of numbers of parasites. Fluid was withdrawn, mixed with diluting/fixing solution and counted in a haemacytometer. Although marked by wide variation in counts, the number of parasites in all infected embryos increased, some to the extent of 25-fold. Initial attempts to establish infection in embryos incubated at 37° C were unsuccessful, but when infected embryos which had been held at 30° C for several days were moved to 37° C there was a distinct increase in numbers of parasites.

33. **Enhanced Virulence of a Strain of *Plasmodium lophurae* Following Prolonged Serial Passage in Chicks.** ROBERT W. HULL, Department of Biological Sciences, Northwestern University, Evanston, Illinois.

A strain of *Plasmodium lophurae* obtained from the National Naval Medical Research Institute in 1954, where it was maintained in turkey poults, has been maintained for 4 years by serial blood inoculation in chicks ranging from 6 to 30 days of age. Inoculations into uninfected chicks were made from donors showing a peak parasitemia between 50% and 60% on the 4th day of infection. Inoculum size was calculated so that this 4th-day peak parasitemia could be consistently achieved. The strain of chicks used was a New Hampshire-White Rock cross available the year around from a commercial hatchery near Chicago, Illinois. Initially, an appreciably larger inoculum was required to achieve 4-day parasitemia peaks between 50% and 60% than is currently required, even when allowance has been made for the minor differences in the ages of the recipient chicks. Calculation of dose response and its statistical validation, the magnitude of the increase in virulence of the strain, and the minor changes in the morphology of the parasite will be presented.

34. **In vitro Development of the Mosquito Phase of *Plasmodium relictum*.** GORDON H. BALL AND JOWETT CHAO, University of California at Los Angeles.

By culturing in vitro various stages of the mosquito cycle of the avian parasite *Plasmodium relictum*, it has been possible to obtain a series from the gametocytes to oocysts in which sporozoites have been seen to develop. Gametocytes are taken either from the blood of an infected bird or from the stomach of a mosquito, *Culex tarsalis*, which has recently bitten a canary having the sexual stages of the plasmodium in its blood. In vitro development of ookinetes occurs in cultures started from gametocytes. Isolated portions of the mosquito digestive tract exposed to ookinetes develop oocysts in 4 days. The latter double in diameter in 24 hours. Oocysts of all sizes up to those that are mature develop in vitro for 5 days, sometimes increasing as much as 3 times in diameter. It is not essential that they be attached to the intact stomach for development during this period. Oocysts persist in culture for 3 weeks. Older oocysts will produce sporozoites internally in culture. Since any particular culture ceases development after 5 days, the series here described has been obtained by combining consecutive stages grown in vitro with adequate overlapping to provide a continuous sequence. Photographs showing the development of single cysts in vitro will be shown.

35. **Free Amino Acid Content of the Adult Tropical Rat Mite, *Ornithonyssus bacoti* (Hirst, 1913).** E. AHMED ZEIN-ELDIN AND J. ALLEN SCOTT, The University of Texas Medical Branch, Galveston, Texas.

As part of a larger project dealing with studies on nutritional and immunological aspects of filarial infections in cotton rats and rice rats, the filaria vector, *Ornithonyssus bacoti* was studied for its amino acid composition. Adult mites fed on filaria-free white rats and then starved for periods of 10–40 days were used in this study. Preparation of samples for paper chromatography was carried out by a method based on that of Awapara (1948). The mites were etherized in batches of 500, then homogenized and extracted in 10 ml of 95% ethanol. A few hours later, the insoluble material was removed by filtration and the filter paper washed twice with a total of 10 ml of 70% ethanol. The filtrate was then mixed with 3 volumes of chloroform, shaken, and the upper aqueous layer recovered in a separatory funnel. This solution containing the free amino acids was then concentrated on a water bath to a volume of 0.5 ml so that 1 microliter of the concentrate would represent approximately one mite. Whatman No. 1 and No. 3 filter paper were used for ascending 1-dimensional and 2-dimensional chromatography. The solvents used were buffered phenol, n-butanol-acetic acid, and 70% n-propanol. Ninhydrin (0.2% solution in water-saturated *n*-butanol) was used for developing. Known amino acids were run simultaneously with every determination. The following amino acids were identified: Alanine, glutamic Acid, glycine, leucine, lysine, methionine, proline, serine, taurine, threonine, tyrosine, and valine. This amino acid pattern appears to be consistently maintained in extracts of mites starved for 10, 15, 20, 25, 30 and 40 days. Good separation of amino acids is, however, obtained only from extracts of mites which have been starved for no less than 10 days. (Supported by the James W. McLaughlin Foundation, The University of Texas Medical Branch.)

36. **A Study of Some Ecological Factors Influencing Acarine Populations of Egyptian Gerbils' Burrows.** C. E. YUNKER, The University of Maryland.

Ectoparasitic mite populations of *Gerbillus gerbillus* (Olivier) and *G. pyramidum* Geoffroy and their environments were studied in desert and semidesert areas near Cairo,

Egypt from September, 1956, to August, 1957. Burrows of both species were similar but differed in each area. Acarine populations were statistically analyzed according to 4 environmental factors: Presence or absence of host, area, time of year, and climatic state of burrow. Species of mites were analyzed according to area or host specificity and nest-dwelling or permanently parasitic habits. It was determined that the presence or absence of mites in a nest depended on occupancy of the burrow by the host, while population size was affected by area. *Androlaelaps marshalli* Berlese showed no host specificity but was usually restricted to semidesert burrows. *Hirstionyssus craticulatus* Keegan and *Haemolaelaps aegyptius* Keegan were randomly distributed on either host and in either area. *Hirstionyssus craticulatus* and the ticks (*Rhipicephalus* sp. and *Hyalomma* sp.) were completely dependent upon the presence of a host. The effective environment of the mite populations was shown to be the host and burrow while that of the ticks included the external environment as well. Correlation of abundance of ticks with seasonal macroclimatic events was demonstrated, which was not evident for mite populations. Presence or absence of mites in a burrow was found to be related to vapor pressure deficit of the burrow, but this relation could not be separated from the influence of area or time of year in which collections were made.

37. **Additions to the Tick Fauna of Indiana (Acarina: Argasidae, Ixodidae).** NIXON WILSON, Department of Entomology, Purdue University.

Studies of ectoparasites occurring in Indiana have added the following 8 species of ticks to the list of those known to occur in the state; *Ornithodoros kelleyi* Cooley and Kohls, *Ixodes brunneus* Koch, *I. dentatus* Marx, *I. marxi* Banks, *I. muris* Bishopp and Smith, *I. sculptus* Neumann, *I. woodi* Bishopp and *Amblyomma americanum* (Linnaeus). In addition, 5 species, previously recorded in the literature, have been collected during the study. These are: *Ixodes cookei* Packard, *I. texanus* Banks, *Dermacentor variabilis* (Say), *Haemaphysalis leporis-palustris* (Packard) and *Rhipicephalus sanguineus* (Latreille). An additional species, *Ixodes scapularis* Say, has been reported from the state, but has not been taken during the current study. The number of ticks known from Indiana is increased to 14 species with these additions.

38. **The Variation in Laboratory Bred Ticks.** B. FELDMAN-MUHSAM AND J. KAHN, The Hebrew University, Jerusalem, Israel.

The variability of different characters which serve for identification of ticks was studied in the progeny of several females. The study covered *Hyalomma excavatum, H. marginatum, H. truncatum, H. glabrum,* and *H. rufipes.*

It was found that most characters such as size, form, punctation, relief and color of the scutum, form and size of the anal plates and of the stigma are on one hand very similar in all species studied, and on the other hand vary very considerably within the progeny of 1 female. Haller's organ which is claimed by some acarologists to be of diagnostic value, was found to be unreliable in the species studied. The presence or absence of peristigmal hairs was found to be less variable, in some species. The best character for identification which was found so far, is the form of the female genital aperture, although some variability exists even here.

The lesson to be learned from this study is that a few specimens of a dubious character should not be rashly attributed to the species which they resemble most, if this species has not been known from the area in which the specimens were found. In such cases it should first be ascertained, whether these specimens are not within the range of variation of another species known to thrive in the same area.

39. **Capacity of Different Strains of *Entamoeba histolytica* from Infected Persons in Ward Siloé, Cali, Colombia to Ingest and Digest Starches Consumed by the Human Hosts.** THOMAS R. READ, AND ERNEST CARROLL FAUST, Tulane University, New Orleans, Louisiana, and University of Valle, Cali, Colombia (International Cooperation Administration, Mutual Security Program of the United States Operational Mission to Colombia).

During a parasite survey of residents of Siloé, an unsanitated ward of Cali, the incidence of *E. histolytica* was found to be 40%. Undigested starch grains were frequently present in direct fecal films in sufficient amount to obscure small parasite objects. Since the basic diet of this population is carbohydrate, it was evident that they consumed starch in excess of their ability to digest it. Because the starch was available for use by *E. histolytica* in the lumen of the large intestine, it seemed desirable to test the capacity of this ameba to ingest and digest the starches commonly consumed.

Cultures of *E. histolytica* grown in Balamuth's medium with rice powder as a substrate

served as controls. Trophozoites from these cultures were subcultured with the following substituted starches: corn, yucca, plantain, wheat (flour), potato, and white sweet potato. Transfers were made every 48 hours. By the 5th subculture all traces of rice starch, transferred in decreasing amounts with the amebas, had usually disappeared. Even though some of the starch grains were as large as the vegetative amebas (viz., potato 25–35 microns), trophozoites of the large race engulfed and digested them. With the exception of corn starch, in which the amebas survived only through the 16th subculture, the amebas with the starch substitutes thrived through the 22nd to 29th subcultures, when the tests were terminated. Quantitatively, in the order of supporting abundant growth of trophozoites, the starches ranked as follows: Wheat (flour), potato, yucca, white sweet potato, plantain and corn. It is concluded that with the possible exception of corn, the starches tested can be utilized by *E. histolytica* trophozoites in the large intestine of the human host.

40. **Effect of Sodium Ricineoleate on** *Entamoeba histolytica.* MITSURU NAKAMURA AND PHILIP R. EDWARDS, JR., Montana State University.

Rice powder and charcoal are routinely incorporated in many culture media for *E. histolytica.* Since both rice powder and charcoal may adsorb surface active agents, thus elevating the surface tension (ST), the possibility exists that one important function of these additives in amoebic cultures may be the maintenance of a proper ST level. This may, in part, explain the difficulty in maintaining amoebae in cultures in the absence of rice powder. This investigation was undertaken to study the effects of sodium ricineoleate, a surface tension-depressing agent, on *E. histolytica,* both in the presence and absence of starch and charcoal.

Sodium ricineoleate was added to tubes of Ringer-egg-serum medium in various concentrations. After adding approximately 10 mg of rice powder to each tube, the tubes were inoculated with the amoebae (US-105), incubated, and counted. The growth was compared with control tubes not containing sodium ricineoleate. Marked inhibition of amoebic growth was noted in tubes containing the ricineoleate; the inhibition was directly proportional to the concentration of sodium ricineoleate. The addition of charcoal negated the inhibitory activity of this ST-lowering agent, whereas, large amounts (approximately 100 mg) of rice powder were without effect in neutralizing the toxic action of ricineoleate.

From these preliminary data it appears that a systematic study of the role of ST in amoebic growth may be of value; future experiments are planned with a variety of ST-raising and ST-lowering agents under conditions whereby the ST can be measured accurately with a tensiometer. (This study was sponsored by the Commission on Enteric Infections, Armed Forces Epidemiological Board, and supported in part by the Office of Surgeon General, Department of the Army, Contract No. DA-49-007-MD-891.)

41. **Studies on the Age Resistance Offered by Rats, Guinea Pigs and Cats against** *Trypanosoma evansi* **Infection.** L. M. YUTUC, University of the Philippines.

In the white rat, age differences did not influence the course of *T. evansi* infection, young and old dying almost at the same time after infection, on the average 11.2 days and 11.1 days respectively. On the other hand, in guinea pigs and cats marked age differences in resistance existed, in the guinea pigs 52.8 days and in the cats 81.2 days in favor of the old subjects. Twenty white rats, 20 guinea pigs, and 10 cats were used in the experiment.

42. **The Blood Protozoa of the Marine Fish of Southern New England.** WILBUR L. BULLOCK, University of New Hampshire.

During the summer of 1953, in the course of work at the Fish and Wildlife Service Laboratory in Woods Hole, Massachusetts, blood smears were made and examined from 209 fish representing 43 species. Of these, 14 fish (6 species) were infected with some species of blood protozoa. *Haemogregarina* sp. was observed in 4 of 19 *Paralichthys dentatus.* A probable infection with a haemogregarine was observed in 1 of 6 *Spheroides maculatus* and a haemogregarine-like parasite was found in the white blood cells of 1 of 7 *Centropristis striatus. Trypanosoma rajae* was observed in 1 of 8 *Raja erinacea.* All infections were relatively to extremely light.

A myxosporidian, apparently *Kudoa* sp., was observed in the blood of *Pseudopleuronectes americanus* (6 of 26) and *Fundulus heteroclitus* (1 of 8). In several of these fish the parasites were numerous. All infected fish, 6 of 12 *P. americanus,* were from the same locality (Nonamessett Island).

In the following fish no blood protozoa were observed: *Caranx crysos* (1), *Ceratacanthus schoepfi* (2), *Cynoscion regalis* (2), *Cyprinodon variegatus* (8), *Dasyatis centrura* (1), *Echeneis naucrates* (2), *Fundulus majalis* (13), *Hyporhamphus unifasciatus* (1), *Leptoce-*

phalus conger (5), *Limanda ferruginea* (1), *Lophius piscatorius* (1), *Lophopsetta maculata* (1), *Menidia notata* (3), *Menticirrhus saxatilis* (1), *Microgadus tomcodi* (4), *Mustelus canis* (3), *Myoxocephalus aeneus* (3), *Oligoplites saurus* (2), *Opsanus tau* (3), *Pomatomus saltatrix* (4), *Poronotus triacanthus* (1), *Prionotus carolinus* (6), *P. strigatus* (2), *Pteroplana micrura* (1), *Raja diaphanes* (2), *R. eglanteria* (3), *Scomber scombrus* (1), *Selar crumenophthalmus* (14), *Sphyraena borealis* (3), *Stenotomus chrysops* (16), *Strongylura marina* (1), *Syngnathus fuscus* (2), *Tautoga onitis* (13), *Tautogolabrus adspersus* (6), *Tetranarce occidentalis* (1), *Trichiurus lepturus* (1), and *Urophycis regius* (3).

43. **Relation of *Escherichia coli* to the Development of the Preparasitic Stages of Various Cattle Nematodes.** H. Ciordia and W. E. Bizzell, Regional Animal Disease Research Laboratory Substation, Agricultural Research Service, U. S. Department of Agriculture, Experiment, Georgia.

Escherichia coli tagged with P^{32} was incorporated with fecal cultures containing eggs of *Cooperia oncophora, Ostertagia ostertagi,* and *Trichostrongylus axei.* The resulting infective larvae from such cultures did not exhibit any radioactivity, although it was expected that the preinfective stages would feed on the bacteria. Further studies using conventional bacteriological techniques indicated that the number of infective larvae was reduced when bacteria were added to cultures prepared with feces freshly voided by infected cattle (40% development), or when added to cultures made with sterilized feces (25% development), as compared with control cultures without *E. coli* (65% and 30% development, respectively). Even though the yield of infective larvae from control cultures prepared with bacteria-free eggs and sterile moss was very low, only a few larvae were recovered when similar cultures were inoculated with *E. coli,* possibly indicating that there was a lack of food for the developing larvae. Infective larvae were never recovered from cultures containing bacteria-free eggs, sterile moss, water extract of feces sterilized by Seitz filtration, and *E. coli,* whereas only very few larvae were obtained from control cultures without the bacteria. Comparable results have been obtained using 3 strains of *E. coli.* Further work is in progress in an attempt to determine the nutritive requirements of the preinfective stages of these cattle nematodes.

44. **Parasites in a Selected Group of Swine in Alabama.** Elliott Lesser and C. D. Squiers, Regional Animal Disease Research Laboratory, Agricultural Research Service, U. S. Department of Agriculture, Auburn, Alabama and Animal Husbandry and Nutrition Department, Alabama Agricultural Experiment Station, Auburn, Alabama.

A survey of parasites in a selected group of swine was conducted from September 1957 to February 1958 at the Alabama Agricultural Experiment Station. Repeated examinations of fresh fecal samples were made by direct smears and the formalin-ether concentration technique.

The following parasites were found in 19 sows that were brought onto individual concrete pens for farrowing: *Entamoeba polecki* (100%), *Balantidium coli* (89.5%), *Iodamoeba butschlii* (89.5%), *Eimeria debliecki* (63.2%), *E. polita* (47.4%), *E. scabra* (47.4%), *Chilomastix* sp. (21.1%), *Giardia* sp. (one sow), *Hyostrongylus* and/or *Oesophagostomum* spp. (100%), *Ascaris suum* (31.6%), *Strongyloides ransomi* (31.6%), *Gongylonema pulchrum* (1 sow), and lungworm (1 sow).

Pigs were farrowed in September and remained with their dams until weaned (a period of 56 days). During this time the 19 individual litters were examined, and the following parasites found (percentages refer to litters infected): *E. polecki* (73.7%), *I. butschlii* (57.9%), *B. coli* (47.4%), *Eimeria debliecki* (10.5%), *E. polita* (10.5%), *E. scabra* (1 litter), *Chilomastix* sp. (10.5%), *S. ransomi* (79.0%), and *A. suum* (1 litter).

After weaning, the litters were divided into 16 groups of 6 pigs per concrete pen. Examinations of these groups, while they remained on concrete from November to February, yielded the following results: *B. coli* (93.8%), *E. polecki* (81.3%), *I. butschlii* (37.5%), *Eimeria debliecki* (1 group), *E. polita* (1 group), *E. scabra* (1 group), *A. suum* (75.0%), *S. ransomi* (43.8%), *Hyostrongylus* and/or *Oesophagostomum* spp. (21.0%), and *Trichuris suis* (15.8%).

No symptoms of clinical parasitism were observed in any of these swine.

45. **The Relation of Two Weekly Pasture Rotation Systems to the Acquisition of Gastrointestinal Nematodes by Sheep.** Norman D. Levine, Richard E. Bradley and Robert M. Mack, College of Veterinary Medicine, University of Illinois, Urbana.

During the 1957 grazing season a study was carried out to determine the effect of weekly pasture rotation on the acquisition of gastrointestinal nematodes by lambs grazing with their

ewes and also to determine whether the lambs could be successfully grazed separately from their ewes. One group (Group A) of 10 lambs was separated from their ewes and placed on a ¼-acre brome grass-alfalfa pasture May 14. After 1 week they were moved to a second pasture of the same size, and their 8 ewes were placed on the pasture they had vacated. They were rotated in this way thru a series of 6 pastures. Eight lambs and 6 ewes in Group B were kept as unrotated controls on a 1½-acre pasture. Ten lambs and 8 ewes in Group C were rotated together at weekly intervals thru a series of six ¼-acre pastures; these served as unseparated controls. The experiment was ended Oct. 1, after 3-1/3 rotations (20 weeks).

The mean strongylinate fecal egg count of the Group A lambs was 60 e.p.g. (eggs per gram) on May 14; it rose to a peak of 10,538 e.p.g. on Aug 6 and then decreased to 100 e.p.g. on Oct. 1. The mean egg count of the Group B lambs was 0 e.p.g. on May 14; it rose to a peak of 19,455 e.p.g. on Sept. 3 and then decreased to 3470 e.p.g. on Oct. 1. The mean egg count of the Group C lambs was 30 e.p.g. on May 14; it rose to a peak of 4160 e.p.g. on Sept. 3 and then decreased to 1455 e.p.g. on Oct. 1.

The mean weight of the Group A lambs was 48.6 pounds on May 14 and 81.6 pounds on Oct. 1, for a mean gain of 33.0 pounds. That of the Group B lambs was 35.5 pounds on May 14 and 72.0 pounds on Oct. 1, for a mean gain of 36.5 pounds. That of the Group C lambs was 44.6 pounds on May 14 and 79.9 pounds on Oct. 1, for a mean gain of 35.3 pounds.

It was concluded that none of the grazing systems employed in this experiment was effective in preventing a high degree of parasitism or in producing satisfactory weight gains.

46. **Experimental Cross-Transmission of Two Strains of *Haemonchus* from Wild Ruminants to Domestic Sheep, with Observations on Their Pathogenicity as Compared with *Haemonchus* from Domestic Sheep.** REX W. ALLEN, G. A. SCHAD, AND K. S. SAMSON, Animal Disease and Parasite Research Division, ARS, U.S. Department of Agriculture, State College, New Mexico.

During 2 consecutive years fecal samples containing worm eggs were collected from non-captive Bighorn sheep (*Ovis canadensis*) and Barbary sheep (*Ovis tragelaphus*), and were cultured by standard methods. The larvae from each host species were administered to separate parasite-free domestic lambs. Infective larvae cultured from eggs obtained from *Haemonchus* females recovered at necropsy from these lambs served as the source of the experimental infections. Two additional passages in lambs were required to provide enough infective larvae for the test inoculations; 15,000 per lamb for the first experiment, and 13,000 per lamb for the second.

The test lambs were divided into 4 comparable groups of at least 3 lambs each. Group 1 received the Barbary sheep strain; Group 2, the Bighorn sheep strain; Group 3, a domestic sheep strain; and Group 4 received no larvae and served as uninfected controls. Observations were made at weekly intervals during a 74- to 77-day period. Lambs receiving the strains of *Haemonchus* from the wild ruminants gained significantly more weight and maintained significantly higher hemoglobin levels than the lambs receiving the domestic strain. Average numbers of worm eggs per gram of feces and average numbers of worms recovered post mortem from the lambs in the various groups supported the clinical data. Measurements of the significant features of the male worms of all strains showed that the majority were within the range specified for *Haemonchus placei* by Roberts *et al* (1954, Austral. J. Zool. **2**: 275–295).

47. **Observations on Early Development of *Ascaridia columbae* in the Pigeon.** JOSEPH C. HWANG AND EVERETT E. WEHR, Animal Disease and Parasite Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland.

Embryonated eggs of *Ascaridia columbae* were obtained from whole female worms, partially submerged in water containing 1% formalin, and held for 1 month in a closed container. Infections were produced in 14 adult pigeons by administering the embryonated eggs per os. The pigeons were sacrificed 24, 43, 48, 72, 91, 144, 163, 192, 235, 240, 312, 331, 379, and 408 hours, respectively, after the eggs were administered. The entire digestive tract, with the liver, pancreas, and gizzard intact, and the lungs and heart were removed, and each organ was examined separately in physiological saline. Portions of the liver and intestines were preserved for sectioning.

Larvae of *A. columbae* were recovered from the intestine 24 hours after infection, but not from other organs and tissues. Nineteen hours later the larvae appeared in the liver, but were absent from the intestine and the other organs and tissues examined. On the 13th day (312 hours after infection) a few larvae were recovered from the intestinal tract and the liver. By the 17th day (408 hours after infection) many larvae were recovered from the intestinal tract, although a few were still in the liver.

These observations show that passage through the liver may be a normal and necessary part of the life cycle of *A. columbae*, and that penetration of the intestinal wall by the developing larvae before they appear in the intestinal lumen does not necessarily occur, although it does take place in the life cycle of the closely related ascarids.

48. **Studies on "Self-cure" and Acquired Resistance to *Heterakis* Infections in Chickens and Turkeys.** EVERETT E. LUND, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

Chickens receiving challenge feedings of 200 embryonated eggs of *Heterakis gallinae*, administered 4 weeks after an immunizing dose of 200 such eggs, gave no evidence of the "self-cure" phenomenon (expulsion of worms from the initial feeding). Larvae of 10–18 days, resulting from the challenge feeding, were about 20% fewer than those in challenge-control birds. Much of this was actual reduction in numbers, but a part may have been retardation, some larvae having been slow in emerging from the cecal mucosa.

Comparable lots of 25 chickens were challenged by feeding *Heterakis* eggs carrying a pathogenic strain of *Histomonas*. Again, no "self-cure" was obtained, but in birds not developing blackhead the larvae resulting from the challenge feeding were fewer than half as numerous as those in the challenge controls, which had had no previous *Heterakis* infection. Blackhead appeared in more than 70% of these chickens, and worm removal was high in all birds with histomoniasis, regardless of the age of the worms.

Comparable tests with turkeys gave results similar, for the most part, to those summarized above.

It is concluded that *Heterakis* larvae developing in chickens and turkeys have little or no effect on mature worms already present, but that in 4 weeks the host has developed some resistance as a result of the earlier infection. This resistance may be expressed as a diminution in numbers of larvae, and to some extent in retardation in development.

49. **The Life History and Development of Toxascaris leonina (von Linstow 1902) in the Dog and Cat.** J. F. A. SPRENT, University of Queensland.

Dogs and cats were infected with feline and canine strains of *Toxascaris leonina;* infection was produced from eggs, and from larvae in experimentally infected mice. Second-stage larvae, characterized by knobbed tail, oral prominence, and circum-oral cuticular flange, were found in the intestinal wall of mice for the first 7 days after infection, thereafter in the somatic tissues, and also in the intestinal wall and intestinal contents of egg-infected cats at 5–14 days after infection. Length of second-stage larvae 0.19–0.65 mm. The second molt (length 0.42–0.63 mm) was observed in mouse tissues at 8–12 days, and in the intestine of egg-infected cats at 7–14 days. Third-stage larvae, differentiated by lack of the oral prominence, were found in tissues of canine-strain infected mice from 9 days, and in feline-strain infected mice from 21 days, also in the intestinal wall and intestinal contents of egg-infected dogs and cats at 18–35 days, and in mouse-infected cats 13–28 days. Length of feline-strain third-stage larvae was 0.47–0.72 mm, that of the canine strain, 0.49–0.82 mm. The third molt (length 0.62–0.74 mm) was observed in intestinal wall of cats and dogs at 21–35 days after infection. Fourth-stage larvae, with adult-type lips and pointed, dorsally curved tail, appeared in the intestinal contents of egg-infected cats at 21 days, mouse-infected cats at 18 days, egg-infected dogs at 32 days. Length of fourth-stage larvae was 0.52–9.6 mm. Sexual differentiation, as shown by development of tail, vagina and spicules, was evident at 2 mm. The fourth molt (length 7.7–11.7 mm) observed in a mouse-infected cat at 35 days, in an egg-infected cat at 42 days, in an egg-infected dog at 42 days. The adult stage was found in intestinal contents of an egg-infected cat at 28 days, and in an egg-infected dog at 38 days. Eggs appeared in feces of an egg-infected cat at 74 days and in a mouse-infected dog at 56 days. Adult stage was differentiated by constriction behind the lips, minute cuticular striations, caudal papillae in male, open vulva in female; the smallest adult was 8.4 mm.

50. **Blood and Plasma Volume, Total Serum Protein, and Electrophoretic Serum Fractionation of Calves Experimentally Infected with *Trichostrongylus axei*.** S. E. LELAND, JR., J. H. DRUDGE, AND Z. N. WYANT, Kentucky Agricultural Experiment Station, Lexington.

Sixteen calves (14 Jerseys and 2 Holsteins) 3 to 5 months old at the time of infection were used in the study. Pre- and post-infection measurements as well as parallel measurements on uninfected control animals were made over a 4-month period. The range of single doses of larvae was 5,000 to 1,500,000.

The most consistent and prominent serum protein alterations were (1) an extensive and

prolonged hypoproteinemia as evidenced in grams/100 ml and total grams of circulating protein and (2) a hypoalbuminemia with an increase or maintenance of the alpha-2-globulin level and in general a decrease of the other globulins all of which are manifested in percent composition, grams/100 ml, and grams of total circulating component.

The sequence of events with respect to blood and plasma volumes in infected animals appears to be a development of polycythemic hypovolemia which, if the animal survives, develops into an oligocythemic hypovolemia.

51. **Larval Migration and Accompanying Pathological Changes in Experimental Ovine Strongyloidiasis.** JAMES H. TURNER AND WILLIAM T. SHALKOP, Animal Disease and Parasite Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland.

The infective larvae of *Strongyloides papillosus* are tissue penetrators, and may occur, at least as transients, in various tissues and organs of the host. The migration of these larvae in experimentally infected lambs was investigated in order to ascertain (1) the route of migration during and after skin penetration, and (2) the pathology elicited by the migrating larvae. Larval migration through the skin was studied from biopsy specimens; otherwise the studies were conducted on lambs killed from 12 hours to 15 days after percutaneous infection.

Larvae were present in the skin from 15 minutes to 48 hours after infection, but little damage to cutaneous tissue, except for slight hemorrhage and edema, was observed. More larvae were present in the blood at 12 and 24 hours than later, and they were more numerous in venous than in arterial blood. Larvae were not recovered from the circulating blood later than 72 hours after infection. Larvae were recovered from the lungs and musculature as early as 12 hours after infection, but were not detected in the gastrointestinal tract until about 3½ days later. Gross lung damage was first observed 2 days after infection and reached its maximum about 3 days later. At this time the lung surfaces were covered with petechiae and ecchymoses. Histopathologic changes of the lungs included acute hyperemia along with interstitial extravasation of blood, and edema. Damage to the intestine in the form of a severe catarrhal enteritis was generally confined to the duodenum and jejunum.

52. **Observations on the Association of Esophageal Sarcomas with *Spirocerca lupi* Infection in the Dog.** W. S. BAILEY AND WILLIAM E. RIBELIN, Alabama Polytechnic Institute.

Malignant neoplasms of the esophagus of the dog are generally considered to be very rare. Sixteen cases of esophageal sarcoma (fibrosarcoma or osteosarcoma) were encountered in 1,969 dogs approximately 6 months of age or older which were autopsied during the period 1950–1957. All of these occurred in the 163 dogs of this group that had been infected with *Spirocerca*. Most of the malignant neoplasms were in hounds or bird dogs.

53. **The Morphogenesis of the Parasitic Stages of the Cattle Lungworm, *Dictyocaulus viviparus*, in Experimentally Infected Guinea Pigs.** FRANK W. DOUVRES AND JOHN T. LUCKER, Animal Disease and Parasite Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland.

The infective larvae of *Dictyocaulus viviparus* used for experimental infections were obtained by culturing first-stage larvae isolated from the manure of a calf infected with this parasite. Single doses of 120,000 to 450,000 infective larvae were administered per os to 18 laboratory-reared guinea pigs, which were killed at various intervals between 18 hours and 30 days after infection. The morphological diagnoses of the developmental stages were made from worms recovered from normal saline washings of macerated lung tissue.

Larvae in the parasitic third stage, third molt, fourth stage, and fourth molt and immature worms in the fifth stage were recovered 18, 23, 43½, 144, and 154 hours after infection respectively. The identifying anatomical features of the various stages were as follows: *Third stage*.—Unsheathed; 4 refractive ovoid bodies, 2 subventral and 2 subdorsal, present adjacent to histologically modified anterior tip of esophageal procorpus; tail terminating in 1 or more tubercles. *Third molt*.—Identical to third stage, except for sheath. *Fourth stage*.—Unsheathed; region between histologically modified anterior tip of esophageal precorpus and body wall without refractive ovoid bodies, but appearing optically clear in contrast to the very granular appearance of neighboring tissues. *Fourth molt*.—Ensheathed; primordial vulvar lips present, genital primordium elongate but not differentiated in females; males with body swollen at anal level in early phase and with bursa and bursal rays formed in late phase; cephalic region as in fourth stage. *Fifth stage* (immature).—Unsheathed; females with vulvar opening but with organs of reproductive system undifferentiated; males with developing spicules and fully

formed bursa and bursal rays; esophageal procorpus without histological modification; prominent buccal capsule present; cephalic cuticle inflated.

54. **The Incidence of Helminth Lung Parasites of *Lynx rufus rufus* (Shreber) and the Life Cycle of *Anafilaroides rostratus* Gerichter, 1949.** H. L. KLEWER, Virginia Polytechnic Institute.

Examination of the lungs of 24 bobcats in Virginia revealed 4 nematode and 1 trematode species of parasite. Adult specimens of *Anafilaroides rostratus* (Gerichter, 1949) were recovered from 23 of the cats. Twenty-two of the animals harbored *Troglostrongylus wilsoni* (Stough, 1953), 3 contained *Metathelazia felis* (Vogel, 1928) and 8 harbored another *Metathelazia* species which is probably *M. californica* (Skinker, 1931). *Paragonimus rude* (Diesing, 1850) was present in the lungs of 5 animals.

Progress has been made toward establishing the life cycle of *Anafilaroides rostratus* by the production of experimental infections in domestic kittens.

Larval development has been studied in laboratory-reared slugs (*Limax maximus*) which serve as an intermediate host. After penetration of the first-stage larvae a first molt occurred in the foot muscle of the slug between the sixth and seventh day. A second molt was completed by the tenth day, at which time 2 sheaths were retained around the third-stage larvae. Infective larvae, free of the surrounding sheaths were observed by the eleventh day. Observations were made on the growth and morphologic changes and recorded by camera lucida drawings of live and heat-killed specimens.

Snail tissue containing infective stage larvae is being fed to a rodent to ascertain if a transport host is involved in the life cycle of this parasite.

Further studies are also being carried out to determine the pathway of infection in the definitive host.

55. **Observations on Swine Experimentally Infected with the Kidney Worm, *Stephanurus dentatus*.** F. G. TROMBA, Animal Disease and Parasite Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland.

In 1955 (J. Parasitol. **41**: 157–161) the writer reported that earthworms could serve as facultative intermediate hosts for the kidney worm, *Stephanurus dentatus*. Since that time observations have been made throughout the prepatent period on additional pigs infected by feeding parasitized earthworms (*Eisenia foetida*) and these data have been correlated with results obtained from earlier experiments in which infective larvae were directly administered in single and multiple doses.

Fifteen pigs, ranging in age from 13 to 98 days, were infected: 6 by direct administration of single doses of 1,000 to 5,000 infective larvae, 4 by direct administration of multiple doses totaling 1,000 to 1,150 infective larvae, and 5 by feeding approximately 750 infective larvae in parasitized earthworms. All infected animals developed an eosinophilia which began 2 to 3 weeks after infection, reached peak values of 20.5 to 39% within a month after infection, and declined slowly thereafter to normal values of approximately 1 to 5%. The most severe sequelae, including loss of weight, lowered hemoglobin values, and death of 4 pigs 93 to 180 days after infection, were produced by doses of 2,000 or more larvae. Of the 11 survivors, 1 from the group receiving single doses, 1 from the group receiving multiple doses, and all 5 of the group receiving infected earthworms became patent from 240 to 342 days after infection as determined by the presence of eggs in the urine or by the recovery of gravid females at necropsy.

56. **Vital Staining of Blood Parasites with Acridine Orange.** NATHANIEL ROTHSTEIN, Division of Veterinary Medicine, Walter Reed Army Institute of Research, Walter Reed Army Medical Center, Washington, D. C.

A technic has been devised for the vital staining of blood parasites which has permitted the microscopic observation of differentially stained leucocytes, extracellular and intracellular parasites and parasitized erythrocytes, after addition of acridine orange in concentrations up to 1: 50,000 to heparinized blood samples. Material was initially examined with the aid of dark-field illumination, using a blue-violet filter at the tungsten light source and a yellow filter in the eyepiece. Under these conditions, thick suspensions no longer presented a problem in the rapid scanning for blood parasites. The multi-layer thickness of erythrocytes was neutralized, permitting one to scan rapidly for the stained parasites.

Malaria-parasitized canary and rat blood samples were examined, using both ordinary dark-field and fluorescence microscopy. The bleaching of the red color of the parasite by the mercury vapor lamp in the latter system could be impeded by the introduction of an

auxiliary blue-violet filter to the system. Microfilaria of *Dirofilaria* and *Dipetalonema* are stained within minutes and become moribund if kept in the microscopic field. This photodynamic inactivation interval was shown to be inversely proportional to dye concentration. There was no apparent deleterious effect of the dye on the microfilariae as long as the stained organisms were not exposed to light. They have been viable for as long as 15 days after addition of dye, with many having undergone morphological change, resembling forms usually seen in the mosquito.

57. **Observations on the Development of *Cooperia punctata* of Cattle in Rabbits.** JOSEPH E. ALICATA, University of Hawaii.

In connection with studies on the possible development of *C. punctata* in laboratory animals, young rabbits have been fed infective larvae of this parasite cultured from eggs in feces of naturally infected young cattle. In one trial, five 4-week-old rabbits were given several hundred infective larvae by mouth. At necropsy one month later, 14 to 25 adult *C. punctata* were recovered from the small intestines of the rabbits. In another trial, each of four 8-week-old rabbits were similarly given about 20,000 infective larvae. At necropsy 16 days later, from 2 to 16 adult *C. punctata* were recovered. Examination of the feces of these rabbits by salt flotation at necropsy did not reveal eggs of the parasite. Most of the adult female parasites recovered from the intestines of the rabbits contained unsegmented eggs in the uteri; however, a few showed eggs in the early cleavage.

At the time of infection and subsequently, the rabbits had free access to water and complete commercial pellet ration. The above observations indicate that the rabbit is not a very satisfactory host for *C. punctata*.

58. **Preliminary Report on Helminths of Beef Cattle in Arizona.** L. W. DEWHIRST, R. J. TRAUTMAN AND W. J. PISTOR, University of Arizona, Tucson.

Results of a survey during the past year employing eggs per gram (EPG) and larvae per gram counts on fecal material, and post mortem examinations revealed that the following helminth parasites are present in Arizona beef cattle: *Haemonchus* sp., *Oesophagostomum radiatum*, *Trichostrongylus* sp., *Ostertagia* sp., *Cooperia* sp., *Bunostomum phlebotomum*, *Nematodirus* sp., *Trichuris* sp., *Capillaria* sp., *Setaria cervi*, *Fasciola hepatica* and *Moniezia* sp.

Approximately 94% of 865 fecal samples examined were positive for helminth eggs. The average EPG count for all animals examined was 67.5.

When divided into feedlot, irrigated pasture and range animals, the average EPG counts were markedly different. Cattle maintained in feedlots averaged 102 eggs per gram of fecal material. Those on pasture exhibited an average EPG count of 232 while range cattle were lowest with an average of 19.6 eggs per gram.

In order to determine the possible origin of relatively high infections in animals on irrigated pastures, grass and soil samples were randomly collected from pastures on which such cattle were maintained. When computed on the basis of numbers of infective larvae per pound of forage, numbers as high as 2300 were encountered. Similar counts at bi-weekly intervals during the fall and winter after all cattle were removed showed that the numbers of infective larvae declined but were still sufficiently high the following spring to warrant serious consideration by cattle owners.

59. **Occurrence of *Onchocerca armillata* Railliet and Henry, 1909, in Sudanese Cattle, *Bos indicus*.** EMILE ABDEL MALEK, University of Khartoum, Sudan.

The filariid, *Onchocerca armillata*, is very commonly found in Sudanese cattle, *Bos indicus*, where it inhabits the thoracic portion of the aorta and the brachiocephalic trunk. Originally described from Malaya, it has later been recorded from *Bos taurus* in Egypt, *Bos indicus* in India and from the African buffalo *Bubalus caffer* in the Belgian Congo. Large caseous granular nodules containing the anterior end of the female, sinuous tracks, often calcified, containing the male and the long posterior end of the female, and an uneven intima are characteristic of this infection. Morphological details coincide with those reported by Railliet and Henry (1912).

The following average prevalences have been recorded by the writer on 18 days over a period of 1 to 2 years: 94% in White Nile cattle at the Kosti abattoir; 96% in cattle imported from Kordofan and Darfur provinces in the west, and slaughtered at the Khartoum and Omdurman abattoirs, and the Kosti Meat Factory. The prevalence is also very high in the southern provinces.

Specimens of the generically close *Elaeophora* (*E. poeli*), which has the same habitat as *O. armillata*, have not yet been obtained from cattle in the Sudan, but are believed to be com-

mon in the buffalo, from which *Elaeophora* was reported in the Belgian Congo. The relationship between the two genera will be discussed later.

60. **Life Cycle Studies on the Nematode *Subulura brumpti* (Lopez-Neyra, 1922) Cram, 1926, and its Distribution in the Sudan.** EMILE ABDEL MALEK, University of Khartoum, Sudan.

Subulura brumpti, a cecal nematode of poultry, reported to occur in various areas including, in Africa, the Belgian Congo, Dahomey and Algeria (Cram, 1927), is also found in the Sudan in the fowl, guinea fowl and turkey. Naturally infected beetles were found in the neighborhood of poultry pens. The life cycle was followed experimentally by force-feeding grasshoppers on entire female worms, which contain fully embryonated eggs. Morphology of the larval stages in the intermediate host coincided with the description given by Cuckler and Alicata (1944) in Hawaii. When 1-day-, 1-week- and 1-month-old chicks were fed on the infective encapsulated larvae, sexually mature males and females were recovered from the ceca 5 to 6 weeks later.

This life cycle is compared to that of *Heterakis gallinae*, where no intermediate host is incriminated and where the eggs are deposited in the 1-cell stage and require an incubation period on the soil. The distribution of both cecal worms in the Sudan, and also in Egypt, is evidently governed by ecological and geographical conditions. In the arid northern and central Sudan only *Subulura* occurs. In the southern part of the country, with high humidity and rainfall, both *Subulura* and *Heterakis* are found (in Malakal and neighborhood) and *Heterakis* becomes more common still further south, in Equatoria Province. In Egypt *Heterakis* is predominant in the Delta, with high humidity due to irrigation, while in arid Upper Egypt *Subulura* predominates, and further south, near the Sudan border, it is believed to be the only cecal nematode of poultry. Extension of agriculture under irrigation in the northern and central Sudan may help in the spread of *Heterakis*.

61. **Further effects of altered gas tensions on activity of plant-parasitic nematodes.** JULIUS FELDMESSER, W. A. FEDER AND R. V. REBOIS, Nematology Section, Tree Fruit Section, and Nematology Section, respectively, Agricultural Research Service, United States Department of Agriculture, Orlando, Florida.

Previous work (J. Parasitol. **40**(Suppl.) and **41**(Suppl.)) indicates that immersion in sealed tap water solutions in which increased oxygen tensions are produced by 400 ppm sodium sulfite, causes reduction and finally cessation of motility among populations of several genera of plant-parasitic nematodes. This work has been expanded to include studies on emergence rates of *Radopholus similis* and *Pratylenchus brachyurus* from lots of parasitized citrus feeder roots exposed to tap water saturated with air, with oxygen and with carbon dioxide. Feeder roots immersed in tap water served as checks. Seven replicated series were run over a 6-month period.

Root samples were maintained in separatory funnels and jars under conditions making possible the rapid removal of already emerged nematodes. Nematodes were collected, examined and counted 1, 3, and 5 hours after exposure to these gases. The totals emerging from roots in oxygenated water after 5 hours were approximately twice those encountered in the control roots and 5 times the emergence rate from the carbon dioxide roots. After 5 hours, all roots were washed in running tap water and stored wet at 70° F for 48 hours. Further counts were then made to determine total numbers of nematodes in the root samples. Final total populations of oxygenated roots are slightly higher than those of the controls and twice those of the roots exposed to carbon dioxide indicating that water immersion causes slight, and low carbon dioxide tensions cause significant reductions in viable nematode populations within citrus roots.

62. **Trehalose and Glucose in Helminths and Other Invertebrates.** DONALD FAIRBAIRN. Macdonald College of McGill University, Macdonald College, Quebec, Canada.

The identification of trehalose as an important constituent of the total carbohydrates in a nematode, *Ascaris lumbricoides* (Fairbairn and Passey, 1957, Exper. Parasit. **6**: 566) and insects (Wyatt and Kalf, 1957, J. Gen. Physiol. **40**: 833) led to the examination of 15 helminths, 1 parasitic protozoan, and 57 other invertebrates, representing all the major phyla, for the presence of this non-reducing disaccharide. Free glucose was also determined in most species. The methods used for trehalose were based on elution of appropriate portions of paper chromatograms, analysis of the eluates for total carbohydrate by the anthrone method; and of acid hydrolysates by the specific reaction with glucose oxidase. In terms of dry weight of tissue, 6 nematodes contained trehalose ranging from 0.06% (*Litomosoides carinii*) to 6%

(*Porrocaecum decipiens* larvae). An acanthocephalan (*Moniliformis dubius*) contained 2.3%, whereas 4 cestodes and a protozoan (*Trypanosoma crusi*) were essentially negative. *Moniliformis* contained much more glucose (3%) than the other parasites. Trehalose and glucose in free-living invertebrates were generally less than 0.4%, the highest concentrations recorded being 1.55% and 4.0%, respectively, in *Bulinus africanus*, a fresh-water gastropod. No obvious correlation with marine, fresh-water or terrestrial habitats was apparent.

63. **The Effect of Stilbestrol Implants Upon the Development of *Trichostrongylus axei* and *T. colubriformis* in the Laboratory Rabbit.** G. H. ROHRBACHER, JR., Regional Animal Disease Research Laboratory, Agricultural Research Service, U. S. Department of Agriculture, Auburn, Alabama.

Two litters of 6- and 8-week-old grade California white rabbits were weaned and divided into 2 groups. Six animals had 12-mg stilbestrol pellets implanted subcutaneously in the cervical region, and 5 other animals were maintained as controls. This amount of stilbestrol caused marked changes in the genitalia of both sexes. All rabbits were maintained on a standard, commercial pelleted rabbit feed with salt and water available ad lib. Eighteen days after implantation all animals were each infected per os with 3,300 *Trichostrongylus axei* (bovine strain) and 6,600 *T. colubriformis* infective larvae.

Thirty days after infection all animals were killed and examined. There was no apparent difference in the number of nematodes recovered from the two groups, nor were there any striking gross pathological changes noted in infected organs. However, the spleens of the animals receiving stilbestrol were approximately 4 times the size of those of the control group.

Experiments are now being conducted to determine whether or not stilbestrol has an effect upon multiple infections of these two parasites.

64. **Dilution Egg Counts of *Nematospiroides dubius* in Mice and Rats.** JOHN H. CROSS, JR., CHARLTON DAWSON, J. ALLEN SCOTT AND ETTA MAE MACDONALD. The University of Texas Medical Branch, Galveston, Texas.

We have reported previously that the white rat is completely resistant to *Nematospiroides dubius*, a parasite of microtine rodents, but that in rats under cortisone administration the parasite develops essentially as it does in mice.

The prepatent period in the rat is 12 to 13 days as compared to 9 to 11 days in the mouse. The duration of infection is approximately 2 months in the rat as compared to 8 months in the mouse.

Dilution egg counts made at regular intervals showed that egg-production in mice increased rapidly to levels of 50,000 to 90,000 eggs per day at about 16 to 18 days after infection. The counts fluctuated about these high levels for 4 to 5 weeks and then decreased at a constant rate until egg-production ceased at 8 months after infection. Immediately after the cessation of egg-production no female worms were found at autopsy. In rats treated as mentioned above egg-production rose to levels of 6,000 to 12,000 eggs per day. Based on the average egg count for 5 days shortly after the peak egg-production and the recovery of female worms at autopsy, the egg-output was found to be 1,500 to 1,800 eggs per day per female worm in mice and 320 to 440 eggs per day per female worm in rats. The output in mice per female worm at the peak of infection was thus approximately 4 times that in rats. (Supported by Research Grant 1213, National Science Foundation.)

65. **Preliminary Studies on *Nematospiroides dubius* (Baylis, 1926).** GEORGE Y. H. LIU, AND M. H. IVEY, University of Missouri.

Studies with *Nematospiroides dubius*, a trichostrongyloid parasite of mice, were directed toward factors concerned with cultivation, infection, and effects of concurrent infection. Fecal cultures were maintained at temperatures from 5° C to 45° C. No development of eggs occurred at 5° C or at 37° C or above, although 5° C cultures would develop upon subsequent incubation at room temperature. The rate of development and survival was dependent on temperature. Prolonged agitation by means of a syringe, used to suspend the larvae in 5% gelatin-nutrient broth, decreased markedly the ability of larvae to establish in mice.

A modified Stoll egg count technique was devised to follow egg-production. Groups of mice were infected with varying numbers of larvae and the egg patterns followed and later correlated with the number of adults recovered at autopsy. Other groups of 8 mice, infected with 50 *N. dubius* each, were superinfected with different parasites, one with 100 *Trichinella spiralis*, another with 100 *Ancylostoma caninum*, a third with 100 *N. dubius*. A fourth group not given a superinfection, served as controls. The group superinfected with hookworm showed a drop in egg-production and subsequently revealed a loss in *N. dubius* adults. None

of the other groups exhibited appreciable loss of egg-production or adult worms. However, the group superinfected with *N. dubius* did show a rise in egg-production correlated with the number of worms harbored. Egg viability was not affected in any group, as revealed by quantitative sterile cultivation techniques.

66. *Aspiculuris* **(Nematoda: Oxyuridae) from the Wood Rats of the Grand Canyon National Park, Arizona.** F. J. KRUIDENIER AND K. N. MEHRA, Zoology Department, University of Illinois.

Four individuals among 28 wood rats (*Neotoma* Say and Ord, 1825), autopsied during an expedition (1954) to survey the mammals of the Grand Canyon, were found to contain a species of *Aspiculuris* Schulz, 1924. The configuration of the cervical alae and their relation to the lateral alae, as well as the presence of a cephalic bulb differentiate the specimens from described species of the genus except *A. asiatica* Schulz, 1927. The shape and extent of the caudal alae differentiate them from that species. Other characteristics correlate with these. A new species of *Aspiculuris* is being proposed.

Infected hosts included *N. lepida* Thomas, 1893; *N. stephensi*, Goldman, 1932; *N. cinerea* (Ord, 1815). None of the *N. albigula* Hartley, 1894 examined were infected with this nematode.

67. **On the Epizootiology of** *Capillaria hepatica* **(Bancroft, 1893) in Algonquin Park, Ontario.** REINO S. FREEMAN, Ontario Research Foundation, Toronto, Canada.

Capillaria hepatica is a common parasite in the liver of *Peromyscus maniculatus* in Algonquin Park, and is occasionally found in 5 other species of rodents. Infections are not uniformly distributed in the population of *P. maniculatus* in the park, but in foci where they occur the incidence is high. The percentage of *P. maniculatus* infected varies directly with the density of the population of this species of mouse. Transmission of infection occurs primarily during the winter and early spring. Carnivore feces are not an important source of infection with this nematode. It is suggested that some release mechanism such as cannibalism, operating within the population of *P. maniculatus* releases eggs into overwintering nests. It is likely that such eggs do not become infective until late the following spring or early summer, and probably are the source of infection for the following winter.

68. **Studies on Parasites of Fishes in South Dakota.** ERNEST J. HUGGHINS, South Dakota State College, Brookings.

The first extensive study of the parasites of fishes to be undertaken in South Dakota is being conducted with the cooperation of the South Dakota Department of Game, Fish and Parks and the Agricultural Experiment Station at South Dakota State College. Two bulletins on the results will be forthcoming. The first will be designed primarily for the nonparasitologist (e.g., for the fishery biologist, game warden, and sportsman). The second will be more technical and will give tables showing the incidence and distribution of all worm and arthropod parasites found.

More than 400 fishes from about 25 different bodies of water (largely lakes) have been examined for worm and arthropod parasites. A preliminary list of parasites found is here presented. TREMATODA: *Phyllodistomum staffordi, Triganodistomum* spp., *Posthodiplostomum minimum centrarchi, Uvulifer ambloplites, Diplostomulum trilobum, Clinostomum marginatum* (the last 4 being metacercariae). CESTODA: *Glaridacris catostomi, Monobothrium ingens, Ligula intestinalis, Marsipometra hastata, Bothriocephalus cuspidatus, Corallobothrium fimbriatum, C. giganteum, Proteocephalus pinguis, P. ambloplitis, P. fluviatilis, Proteocephalus* spp. NEMATODA: *Contracaecum spiculigerum, Contracaecum* sp., *Camallanus oxycephalus, Philometra nodulosa, Cystidicola* sp. ACANTHOCEPHALA: *Pomphorhynchus bulbocolli.* HIRUDINEA: *Piscicola punctata.* COPEPODA: *Argulus biramosus, Achtheres ambloplitis, Lernaea cyprinacea.*

Some of these parasites are quite widespread in South Dakota. Some of them appear to be restricted to a single host species, while others show little host specificity. In a few lakes, the incidence of certain parasites is extremely heavy. These and other factors will be discussed in the final report.

69. **A Microfilaria from the Gila Monster.** ROBERT M. STABLER AND STELLA M. SCHMITTNER, Colorado College and University of Georgia.

For many years a female Gila monster (*Heloderma s. suspectum*) was a member of the senior author's herpetological family. The monster died November 9, 1957. For some year and a half prior to its demise, toe blood filmed between 7 P.M. and midnight was seen to

contain an abundance of sheathed microfilariae. Unfortunately, no periodicity studies were undertaken. Measurements, in microns, of 25 worms from Giemsa-stained slides revealed: average length 261, range 231 to 300; average width 7.4, range 7.0 to 8.4. The sheath averaged 318 in length, ranging from 245 to 383. The worm's anterior end was blunt, the posterior end was tapering and faint striae were observed. A more complete description is planned.

At necropsy, no adult worms could be found and the blood was free of larvae at 11 P.M., shortly after death. A *Trichomonas* sp. was seen in the rectum and an *Hexamita* sp. was found in the duodenum.

The only previous reference to microfilariae in the Gila was that of Ryerson (1949, J. Ent. & Zool. 41: 49–55), who reported larvae in the blood and adults from the heart and aorta. No description was given. The present authors name this form *Microfilaria stahnkei* n. sp., in honor of Dr. Herbert L. Stahnke, who presented the host specimen to the senior author.

70. **The Extraction and Analysis of the Nuclei Acids of** *T. spiralis* **larvae.** ERWIN GOLDBERG, State Univ. of Iowa.

While nucleic acids have been studied in a wide variety of tissues, nothing is known about their occurrence in parasitic helminths. In view of the fact that these compounds, probably more than any other constitutents, are concerned with vital cellular organization and function, an investigation of nucleic acids in helminths seems pertinent to an understanding of the biology of these organisms.

In the present study, pentose nucleic acid (PNA) and deoxypentose nucleic acid (DNA) has been extracted from *T. spiralis* larvae by the trichloroacetic acid and the perchloric acid procedures. The amount of DNA and PNA has been estimated by phosphorus and sugar assay and ultraviolet absorption. From 35–40% of the total tissue phosphorus is found in PNA, while only 8%, at most, may be accounted for in DNA. The typical ultraviolet absorption curve of nucleic acid with a maximum at about 260 millimicrons and a minimum at about 230 millimicrons, is obtained with these extracts.

These preliminary data form the basis of an investigation designed to determine the occurrence and importance of PNA and DNA in *T. spiralis* larvae.

71. **Observations on the Oral Transplantation of Intestinal Stages of** *Trichinella spiralis*. FRANK F. KATZ, The Jefferson Medical College.

In order to determine the intestinal stages of *Trichinella spiralis* which could be transplanted from one host to another per os, mice ("donors") were experimentally infected with trichinae obtained from artificially digested muscles of infected rats. At various time intervals, the donor mice were killed and the intestinal stages of *T. spiralis* were removed by standard procedures. The isolated worms, in saline, were then introduced orally into "receptor" mice by means of a syringe and a blunted 18-gauge needle. In considering the age of the transplanted worms, only the time that elapsed from the initial inoculation of the larvae into donor mice and their subsequent transfer to receptors was taken into account. Twenty-one or more days after inoculation, the mice were examined for larvae to determine if the transplants were successful. To date, it has been possible to recover larvae from receptors that had received worms inoculated into donors 5, 47, 52, and 71 hours prior to the transplantation. However, larvae were not recovered from receptor mice that had been inoculated with worms introduced into donors 24 hours before the transplantation. When worms 47 hours after their initial inoculation into mice were used, only one-half of the hosts yielded trichinae.

72. **Studies on Fecal Transmission of** *Trichinella spiralis*. W. J. ZIMMERMANN, E. D. HUBBARD, AND J. MATHEWS, Veterinary Medical Research Institute, Iowa State College.

Previous studies have shown 8 species of Iowa wildlife were infected with *Trichinella spiralis*. In order to determine the possible importance of these reservoirs as vectors of trichiniasis to swine, 2 modes of transmission have been considered, namely direct consumption of infected carcasses and fecal transmission from infected animals. Few carcasses, with the exception of rats, would be eaten by swine. Therefore, emphasis has been placed on fecal transmission studies. Fox cubs and albino rats have been utilized as donor animals while swine, rats, and fox cubs have been used as receptors. Infected donor animals were placed in cages above the receptor animals at various time intervals after infection. Factors found to control fecal transmission of *T. spiralis* are: (1) Time interval between infection and placement above receptor animals, (2) degree of immunity of donor animal, and (3) size of infective dosage.

Fecal studies utilizing Baermann technic showed that viable larvae passed through the digestive tract with no apparent loss of infectivity.

73. **Role of Rats and Mice in Transmitting *Trichinella spiralis* Through Their Feces.** O. WILFORD OLSEN AND HARRY A. ROBINSON, Colorado State University, Fort Collins.

The question of whether *Trichinella spiralis* can be transmitted through the feces of animals ingesting trichinous meat has been raised by various workers.

McCoy (1938, J. Parasitol. Suppl. **24:** 35) infected normal rats with trichina larvae passed in the feces of immunized rats. Spindler, (1953, J. Parasitol. Suppl. **30:** 34) infected swine by feeding them feces resulting from meals of trichinous meat.

The present study was undertaken to determine the probable role of rats and mice in transmitting *T. spiralis* through their feces.

Following initial meals of meat containing 300 *Trichinella* cysts for mice and 1,500 for rats, 4.9% and 1.8% were recovered in the feces in the form of cysts and larvae from mice and rats, respectively, during the first 24 hours. Four weeks later when these animals were fed the same number of cysts again, they passed 10.5% and 16.9% for mice and rats, respectively. Relatively few larvae passed after 24 hours.

Feces from the first meal of trichinous meat dried 4 to 8 hours produced infections in 3.3% and 5% of mice and rats, respectively, eating them. Feces from the second meal produced infections in 6.7% and 15% of the mice and rats, respectively. Feces kept moist produced infections in 6.7% and 10% of mice and rats, respectively, after the first meal, and 30.0% for mice and 45% for rats after the second meal. Control animals for all these experiments were negative.

Feeding each of 2 young pigs moist feces of mice and rats after the first and second meals of trichinous meat produced infections in all of them. Control pigs remained uninfected.

The greatest number of cysts and larvae appeared during the first 24 hours after ingestion of the first or second meals of trichinous meat.

(This investigation was supported in part by Research Grant E-976 from the National Institutes of Health, U. S. Public Health Service.)

74. **Thelaziasis in California, With a Report on Reservoir Hosts.** E. D. WAGNER AND H. S. BURNETT, College of Medical Evangelists.

The presentation consists of the showing of an 8-minute 16-mm color motion picture of the problem of thelaziasis (*Thelazia californiensis*) in California as concerns the infection in deer, dogs, man, etc. with special consideration given to the reservoir hosts. Of the reservoir hosts, 2 not previously reported will be given. They are the jack rabbit and domestic silver fox. New evidence on the life cycle will be given in connection with the new hosts studied.

75. **An Autogenous Strain of *Culex tarsalis* Coq.** JOWETT CHAO, University of California at Los Angeles.

A colony of *Culex tarsalis* Coq. maintained in our laboratory since 1954 has been found to be capable of reproducing without a blood meal. During the period from November 1957 to February 1958, 5 autogenous generations were raised. The number of eggs per egg case averaged 62 and the rate of hatching 76.5%. The corresponding figures for the non-autogenous strain were 153 and 88%. The generation time for both strains was approximately 23 days. The mosquitoes were kept at a temperature of 80° F. The adults were fed slices of apple and the larvae were fed yeast and Purina chow. (This investigation was supported in part by a Grant E-87 to Dr. G. H. Ball, from the National Institute of Allergy and Infectious Diseases of the National Institutes of Health.)

76. **Studies on the Defense Mechanism of the Oyster, *Crassostrea virginica*.** M. R. TRIPP, Rutgers—The State University of New Jersey.

Any attempt to control molluscs which serve as intermediate hosts for important animal parasites must be based on knowledge of the factors controlling natural immunity in invertebrates. The oyster is suitable for the experimental analysis of such a defense mechanism.

A variety of metabolizable particles (vertebrate erythrocytes, vegetative bacteria, bacterial spores, starch and yeast) were injected intravascularly into oysters. The disposal of erythrocytes, starch, bacteria and yeast cells was determined by microscopic examination, while bacteria and bacterial spores were cultured from tissues. Corollary in vitro experiments were performed to evaluate the role of blood in the overall defense mechanism.

Intravascularly injected particulate matter elicited an extensive leukocytosis. Particles were phagocytized, carried from blood channels to tissues and through epithelial layers to the exterior. Intracellular digestion was found to supplement this migratory process. A spectrum of particle digestibility was observed, ranging from the readily destroyed bacteria through

more resistant erythrocytes and yeast cells to indestructable bacterial spores and starch. Although oyster blood was found to be bactericidal, specific agglutinins or precipitins were not detected.

It was concluded that some microbial agents may be killed by non-specific blood factors, but the ultimate removal and/or digestion of foreign particles is dependent on the constitution of the particle and its ability to resist degradation by intracellular enzymes of oyster phagocytes. (This investigation was supported by a research grant (E-781) from the National Institute of Allergy and Infectious Diseases of the National Institutes of Health.)

77. **Age and Infectivity of the Filariform Larvae of the Rat Nematode** *Nippostrongylus muris*. A. J. HALEY AND C. M. CLIFFORD, Zoology Department, University of Maryland.

Filariform larvae of *Nippostrongylus muris* that varied in chronological age from 1 to 8½ weeks were studied with regard to their infectivity for Sprague-Dawley laboratory rats. Preliminary observations were also made on the fat content, size and activity of the larvae. Infectivity was high and showed no significant change for larvae that ranged from 1 to 4 weeks in age, but beyond this time the infectivity decreased steadily with increasing age. The average infectivity varied as follows: larvae 7 to 14 days old (47.5%), 16 to 25 days old (49.1%), 32 to 44 days old (22.3%), 48 to 60 days old (4.9%). Actually, the infectivity of the oldest larvae tested averaged less than 1%. A study of the fat content, as determined by staining with Sudan dyes, indicated that 70 to 80% of the larvae 1 to 4 weeks of age had large amounts of Sudan positive material in the gut, whereas larvae 6 weeks or older stained weakly or not at all. Larvae 7 to 8½ weeks of age were slightly shorter and thinner and much less active than younger individuals.

78. **Phototactic and Thermotactic Responses of Filariform Larvae of the Rat Nematode** *Nippostrongylus muris* **(Yokagawa, 1920).** JOHN C. PARKER AND A. JAMES HALEY, Zoology Department, University of Maryland.

Previous investigations have claimed that the filariform larvae of various zooparasitic nematodes exhibit both positive phototactic and thermotactic responses. However, in all of the tests on phototaxis, the presence of heat in the system was not controlled. The present work has demonstrated that in the case of *Nippostrongylus muris* the apparent positive response of the filariform larvae to light was actually a response to heat present in the light. In the basic experimental design, a Petri dish containing clear agar was placed 12 inches from a microscope spot lamp. Filariform larvae were placed on the agar 4 cm from the spot of light. Within 1½ hours, 88.0 to 99.3, with a mean of 92.8%, of the larvae had migrated into the light spot. In a companion system in which a 23 centimeter water barrier was placed between the lamp and the agar plate, 0 to 15.2, with a mean of 2.1%, of the larvae migrated into the light. This latter result did not differ significantly from the random migrations of larvae that received no stimulus. Powdered bone charcoal was mixed with agar and when these black plates were tested in the system with the water barrier, 46.7 to 99.6, with a mean of 75.5%, of the larvae migrated into the light. These findings were substantiated by other experiments not reported here.

79. **Experimental** *Trichinella spiralis* **Infections in Bats.** ROBERT M. CHUTE AND DOROTHY B. COVALT, Dept. of Biology, Middlebury College, Middlebury, Vt.

Thirty-two bats of 3 species (*Myotis lucifugus, Myotis keenii,* and *Pipistrellus subflavus*) were infected with *T. spiralis* larvae isolated from rat flesh by artificial digestion. A similar number of bats was used as uninfected controls at each of the experimental temperatures. There was no evidence of differential mortality between experimental and control groups. Since the 3 species of hosts did not appear to offer significantly different environments for the parasite, they are treated as a single group. Bats were fed living *Tenebrio* larvae. Hibernating bats, maintained at 5° C, were aroused and fed every 2 or 3 days during the course of the experiment.

Twelve bats, infected with 100 larvae each, were split into 2 equal groups and held at 5° and 23° C respectively. One animal in each group was killed every day, starting on the second day after infection. Worms were recovered from the intestines of both groups through the 6th day. All worms recovered appeared, both in size and morphology, to be larvae. Recoveries averaged 17 in the 23° group, 7 in the 5° group.

In a similar manner 20 bats were given 500 larvae each and held at 5° C or 35° C, 10 animals at each temperature. Developing or mature adult worms were recovered from the 35° group through the 8th day. Larval worms were recovered from the intestines of the 5° group through the 6th day. The experiment was terminated on the 8th day after infection. Recoveries averaged 35 from the 35° group, 10 from the 5° group.

80. **Experimental *Trichinella spiralis* Infections in Hibernating Hamsters.** ROBERT M. CHUTE AND SUZANNE LEWIS, Department of Biology, Middlebury College, Middlebury, Vt.

Thirteen golden hamsters were infected with 500 *T. spiralis* larvae each. The larvae used were recovered from the flesh of a rat by artificial digestion. Eight of the hamsters were maintained in a cold room at 5° C, the other 5 in the animal room at 18–20° C. The experimental animals were observed at intervals to determine the degree of activity and the respiration rate. Thirteen to 30 observations were made on each animal. None of the animals in the animal room were observed to hibernate. All but 1 of the cold room group were observed in hibernation at least once. The animals were killed between the 35th and 50th day after infection and examined for larval *T. spiralis* by the digestion method. A sample of worms from each recovery was measured.

Larval recoveries averaged 3,580 for the cold room group, 7,320 for the animal room group. In spite of the large difference between the means the difference was just significant at the 5% level, since there was wide individual variation. Larvae from the cold room group averaged 0.05 mm less in length than those from the animal room group (0.64 and 0.69 mm). This difference was significant at the 5% level.

The intermittent nature of hamster hibernation, the infrequency of observations, and the small numbers of hosts and parasites involved in this preliminary study require that any conclusions be tentative. The data suggest, however, that host hibernation reduces both the number and size of *T. spiralis* larvae developing in hamsters.

81. **The Survival of Challenging *Litomosoides carinii* Larvae in Immature and Mature White Rats as Influenced by Cortisone.** LEROY J. OLSON, The University of Texas Medical Branch, Galveston.

A previous report indicated that older white rats offer greater resistance to migrating *Litomosoides carinii* larvae than do younger white rats or cotton rats. In the present study, controlled comparisons were made between the resistance of immature and mature white rats (immunized at 3 and 8 weeks of age, respectively, by subcutaneous introduction of larvae given 31 days prior to autopsy) which were challenged with larvae given 10 days before autopsy. In both age groups, immunization of rats resulted in decreased percentages of challenging larvae completing migration to the pleural cavity, and in increased percentages of these larvae encapsulated by pleural cavity cells, these results were most significant in the mature age group. Daily cortisone injections (30 mg/kg) suppressed larval encapsulation and resistance to larval migration in immunized rats to levels noted in similar rats with a primary infection. Total and differential cell counts of exudate from pleural cavities were made for both experimental and control rats. In the presence of an infection, cell counts were markedly increased with eosinophils and monocytic cells predominating. No correlation could be made between the cellular response and the survival or encapsulation percentages of larvae with respect to previous infection, age, or species of rat, except in mature-immunized white rats where the inflammatory response was exceptionally heavy. Cortisone suppressed the cellular response of immunized and control rats to levels recorded from uninfected rats.

82. **Experimental Low-Level and Single-Dose Sulfonamide Treatment of Bovine Coccidiosis.** DATUS M. HAMMOND, GLEN W. CLARK, MERTHYR L. MINER, W. ARLO TROST, AND A. EARL JOHNSON, Utah Agricultural Experiment Station, Utah State University and Animal Disease and Parasite Research Division. ARS, U. S. Department of Agriculture, Logan, Utah.

In 6 experiments involving 92 calves the efficacy of low-level and single-dose administration of sulfamethazine and sulfabromomethazine in controlling coccidiosis caused by *Eimeria bovis* in calves was investigated. In each experiment 12 to 16 calves 1 to 3 weeks in age were divided into groups of 4 animals each and inoculated with 100,000 to 1,000,000 oocysts, chiefly *E. bovis;* 2 or 3 groups were variously treated with the sulfonamides administered in gelatin capsules. The results indicated that either drug controlled coccidiosis when given in a single dose on the thirteenth day after inoculation at the rate of 1.5 grains per pound of body weight, or when given on alternate days beginning as late as 10 days after inoculation and continuing for at least 8 days at the rate of 0.15 grain per pound of body weight. Treated calves discharged relatively few oocysts and showed only mild symptoms of coccidiosis or none at all, while untreated controls had severe infections. In 1 experiment in which a single treatment was given on the fourteenth day after inoculation, the calves treated with sulfabromomethazine exhibited relatively severe symptoms of coccidiosis while those treated with sulfamethazine did not.

(This work was supported by a grant to the Utah Agricultural Experiment Station from

Merck Sharp and Dohme Research Laboratories, Division of Merck and Co., Inc., West Point, Pennsylvania.)

83. **Some Experiences with the Use of *Syphacia obvelata* as a Test Organism for Detecting Anthelmintic Activity.** JOHN E. LYNCH AND ELEANOR E. HOEGL, Pfizer Therapeutic Institute.

Natural *Syphacia obvelata* infections in laboratory mice have been used extensively for screening chemical compounds for anthelmintic activity. This host-parasite system has advantages because only small quantities of drugs are required and the infected mice are readily available. However, the lack of a standardized infection can cause difficulty in the interpretation and reproduction of results.

This paper is presented to illustrate what we consider the advantages and disadvantages of this screening test. The results from 625 non-treated controls in 125 separate trials will be interpreted in relation to worm burden distribution, age of infection, and influence on subsequent activity of test compounds including established anti-oxyurids.

84. **Compound 1871. A New Anthelmintic. I. Preliminary Studies on the Therapeutic Activity against *Nematospiroides dubius*.** JOHN E. LYNCH AND BARBARA V. NELSON, Pfizer Therapeutic Institute.

Some of the intestinal parasitic species that do most harm to farm animals belong to the family *Trichostrongylidae*. Research workers have been limited in their attempts to find new and more effective agents for use against these disease-producing organisms due to the general inability to adapt such parasites to small laboratory animals.

Barker (1954) has shown that the pathogenesis of *Nematospiroides dubius*, a trichostrongylid of mice, can be compared in certain aspects with other members of the family *Trichostrongylidae*.

It has been our experience with *N. dubius* that standardized infections are easily reproduced in large numbers of test mice.

Established anthelmintics are relatively ineffective against *N. dubius* in that large multiple doses are required to produce measurable activity against our inoculum of 40 larvae/mouse.

Compound 1871 has been found to exhibit a high order of activity against *N. dubius*. The efficacy of this compound has been based on a critical testing method in which worm elimination has been the sole criterion for measuring activity. Doses as low as 12.5 mg/kg are capable of effective activity.

The size of the inoculum does not influence appreciably the activity of compound 1871.

85. **Results from a One-Year Field Trial on the Effects of N-Phenyl-N'-Dichloroacetylpiperazine Daily in the Feed on Natural *Ancylostoma caninum* Infections in Dogs.** WYETH WALLACE, JOHN EMRO AND DAVID W. JOHNSON, Research Division American Cyanamid Company.

Laboratory trials (Hewitt, et al, unpublished) indicated that continuous administration of N-phenyl-N'-dichloroacetylpiperazine reduced hookworm egg-production markedly within 2 weeks and eliminated adult hookworms within 3 to 4 weeks. Observations were made for 1 year on the effect of this compound as a feed additive against natural hookworm infections under field conditions in a Georgia kennel. When fed daily at 20 mg/kg in dry food to 31 adult Skye Terriers, it reduced the hookworm egg counts appreciably as compared to 40 untreated dogs in which the hookworm egg counts were not materially changed during the observation period, except by intermittent therapeutic treatment.

86. **A New Anthelmintic Effective Against *Ancylostoma caninum*.** ROBERT B. BURROWS, The Wellcome Research Laboratories, Tuckahoe, N. Y.

The N-benzyl-N,N-dimethyl-N-2-phenoxyethylammonium salts have shown activity against a large number of intestinal nematodes, but appear to be more effective against the mucosa-dwelling forms. The present work deals with the activity of this series against natural *Ancylostoma caninum* infections in dogs and cats. Single doses of 20 mg/kg or higher have eliminated all hookworms and single doses of 10 mg/kg have given almost complete clearance. *In vitro* the chloride kills hookworms in 15 to 20 minutes at a 1:100 dilution and in about 40 minutes at a 1:200 dilution.

Clinical trails of this anthelmintic against both *Ancylostoma duodenale* and *Necator americanus* are in progress.

87. **Dithiazanine Iodide, An Effective Broad-Spectrum Anthelmintic for Small Animals.** MAX C. MCCOWEN, MAURICE E. CALLENDER, MILO C. BRANDT, FRANK O. GOSSETT, RICHARD P. GREGORY AND RAYMOND F. SHUMARD, The Lilly Research Laboratories, Indianapolis, Indiana.

A broad spectrum anthelmintic compound dithiazanine iodide (*3,3'* diethylthiadicarbocyanine iodide) was found to be highly effective by oral administration against pinworms in mice, ascarids, hookworms, and whipworms in dogs, as well as ascarids and hookworms in cats.

Effect of dithiazanine iodide was also noted against experimental *Trichinella* infections in mice.

88. **The Anthelmintic Activity of Piperazine Dihydrochloride Monohydrate in the Chicken's Diet against *Ascaridia galli* Larvae.** S. KANTOR, A. BLIZNICK AND R. L. KENNETT, JR., Research Division, American Cyanamid Company.

Little has been published on the effect of piperazine on young *Ascaridia galli* larvae, 1 to 14 days of age, particularly with continuous administration in the diet. Piperazine dihydrochloride monohydrate (51% base) reduces the number of young larval *Ascaridia* in chickens at relatively high levels in the feed. There was an approximately 90% reduction in the numbers of larvae compared with the unmedicated controls when concentrations of 0.26% and 0.13% base (51 treated birds at each level) were fed in the diet for 1 or 2 weeks beginning on the day of infection. Though 0.06% base reduced larval numbers by 70% when fed for 14 days from the day of infection (33 birds), in general agreement with Alicata (1958, Poultry Science, **37**: 89), 9 to 10 days at this level was ineffective (18 birds).

With only 1 day of treatment of 10-day-old larvae, much higher concentrations were less effective, since medicated diets of 1.53%, 1.02% and 0.80% piperazine base removed respectively 81%, 37% and 48% of the larvae (29, 30 and 23 treated birds).

89. **Swine Nematode Control in Puerto Rico.** C. R. PEEBLES AND J. D. RIVERA-ANAYA, University of Puerto Rico Agricultural Experiment Station, Río Piedras, Puerto Rico.

Preliminary trials using piperazine have been made on naturally infected swine in the Lajas Valley of southwestern Puerto Rico. In a group of 110 adult swine given a single treatment of piperazine mixed in the feed in concentration of 1 oz per 100 lbs body weight, the average count of 1466 *Ascaris* eggs per gram of feces dropped to 52 e.p.g., and an average of 7 adult ascarids were expelled in the feces. An average count of 3 *Trichuris* e.p.g. remained unchanged. An average count of other nematode eggs declined from 113 e.p.g. to 6 e.p.g.

Subsequently, 24 five-month-old pigs weighing 180–200 lbs. were divided into 3 equal groups, and 4 pre-treatment and 3 post-treatment egg counts made on each individual. In pigs treated with piperazine, the *Ascaris* average count dropped from 1056 to 1 e.p.g., with an average of 8 adult ascarids expelled. In pigs fed a total dose of 2.5 oz cadmium anthranilate over a 3-day period, the *Ascaris* average count dropped from 349 to 127 e.p.g., with an average of 1 adult ascarid expelled. In untreated controls, the *Ascaris* average count during the same period declined from 640 to 585 e.p.g., with no ascarids expelled. Among the 24 pigs, the *Oesophagostomum* pre-treatment average count of 70 e.p.g. was not significantly altered during the post-treatment period. *Strongyloides* and *Trichuris* average counts were less than 2 e.p.g. and 1 e.p.g., respectively. The studies in progress support the effectiveness of piperazine as an ascaricide under conditions of husbandry and climate in Puerto Rico.

90. **The Effects of ½ gram of Phenothiazine on the Development of Infective Larvae of *Cooperia punctata* in Pure Infections in Cattle.** ROY L. MAYHEW, B. G. TORBERT AND G. C. MILLER, Louisiana State University.

We presented in the program and abstracts of the 32nd meeting of this Society the results of low level feeding of phenothiazine in amounts of 1½ to 12 grams of phenothiazine on the development of infective larvae of this species [J. Parasitol. **43**(Suppl.): 19]. The numbers of larvae were greatly reduced in all instances and in some cultures none were recovered. When the drug was not being fed myriads of larvae were recovered in every instance.

Additional experiments indicate that ½ gram is equally effective in reducing the numbers of infective larvae of this species. A total of 16 experiments have been carried out in 5 series. In each of the series from 2 to 4 animals were used and they were so chosen that one was between 18 and 20 months old and the others were 5 to 10 months of age; a total of 7 animals was used. The results were uniformly the same in all animals and in all the

series of experiments, in that the larvae were either eliminated or very small numbers were recovered when the drug was fed. Very large numbers were recovered when the drug was not being fed. The infection was also followed by egg counts during the experiments. Eggs were demonstrated to be consistently present and mircroscopically appeared normal and in good condition.

91. **Observations on the Resistance of a Strain of *Haemonchus contortus* to Single Therapeutic Doses of Phenothiazine.** J. H. DRUDGE, S. E. LELAND, JR., Z. N. WYANT AND G. W. ELAM, University of Kentucky.

In 7 experiments, utilizing a total of 42 lambs raised helminth-free, phenothiazine was consistently more effective in removing a control strain (A) of *H. contortus* than the resistant strain (B) which was originally isolated from a flock with a parasite control problem. The present observations are an extension of the previous studies on these 2 strains, in which the response to small daily doses indicated that strain B had a phenothiazine threshhold 4 to 8 times higher than strain A.

Lambs were experimentally infected with 2,500 larvae and treated approximately 40 days later. The same lot of a commercial preparation of phenothiazine (N.F., Green) was used throughout the study, and administration was via dose syringe equipped with a Whitlock nozzle. Dosage levels were 0.10, 0.25, and 0.50 g per pound body weight. Data on 24-hour fecal egg counts and worms recovered at necropsy on 14 untreated animals were used to estimate the number of worms in the treated animals before treatment. These estimates and the number of worms recovered at necropsy 1 week after treatment determined the removal efficacy of the drug.

The number of animals, the dosage level (gm/lb), and the average removal efficacy on strain A male and female *H. contortus* respectively were: 7 at 0.10 gm = 89% and 98%, 6 at 0.25 gm = 100% and 100%, 1 at 0.50 gm = 100% and 100%. Corresponding values for strain B were: 7 at 0.10 gm = 55.4% and 69.2%, 6 at 0.25 gm = 81% and 97%, and 1 at 0.5 gm = 44% and 76%. Observations on chromosomes in gonadal squash preparations indicated that both strains were *H. contortus*, and free of the closely related *H. placei*.

92. **An Analysis of the Fluctuation of Hookworm Egg Counts of Puppies in a Screening Program.** RALPH THORSON AND JOHN PANKAVICH, Research Division, American Cyanamid Company.

Experimental hookworm infections of young puppies are used in these laboratories for screening and evaluating anti-hookworm compounds. In order to observe the fluctuations occurring in weekly or biweekly egg counts and to establish a criterion for drug activity, data were obtained from 27 untreated dogs. These data show that of 140 observations made, starting 27 to 33 days after inoculation and continued at 1 or 2 weekly intervals for 3 to 39 additional weeks, only 1 egg count decreased more than 75%. If an 80% decrease in egg counts is chosen as the criterion for drug activity, less than 1 in 140 observations might be expected to decrease enough from some cause other than drug effect to lead to a misinterpretation of the action of a compound. In a search for new groups of active compounds, an even less stringent criterion could be used since only 4 of 100 observations during 0–8 weeks dropped more than 71% and only 8 of 100 dropped more than 61%. Although high activity should probably imply a drop in the egg count and subsequent worm burden at autopsy of 90–100%, a drop of greater than 60% caused by a new type of compound may be considered as indication of activity in a screening program. Therefore, 1 dog per compound is usually used for initial screening.

93. **Immunity to *Cooperia punctata* in Pure Infections in Cattle.** ROY L. MAYHEW, B. G. TORBERT AND G. C. MILLER, Louisiana State University.

In total, 25 animals that have been inoculated with pure cultures of larvae have shown immunity to *Cooperia punctata*. This immunity is shown in some animals by developing a very low egg count as a result of the initial inoculation while in others a high egg count will result and be maintained for a time. Egg counts may drop suddenly to zero or to a very low level and remain low for several days; then they may increase somewhat. Following a second sudden drop the count remains low usually but may increase and in turn be followed by a third drop after which it remains low in the animals studied. Following reinoculation a slight increase in egg count may result or the animal may become completely negative. Seven of these animals that have been demonstrated to be immune to *C. punctata* have been inoculated with nodular worm (*Oesophagostomum radiatum*). Larvae and eggs of the latter

species have been recovered following the usual prepatent period. This indicates that immunity to *C. punctata* does not give protection against the nodular worm.

94. **Some Parasites and Their Chromosomes.** ARTHUR C. WALTON, Knox College, Galesburg, Ill.

(Presidential Address)

95. **A Species of *Nosema* (Sporozoa: Microsporidia) Parasitic in the Flour Beetle, *Tribolium confusum*.** A. F. WEST, Purdue University.

In investigations using *Tribolium confusum* for studies in population genetics, a disease that causes considerable losses has been encountered. It evidently is due to a species of *Nosema* with which the insect becomes infected during the larval stage. If the larvae do not die before pupating, death may occur during the pupal stage and relatively few survive to emerge as adult beetles. Examination of the larvae revealed the presence of *Nosema* sp. in the fat body which, in older larvae, contains enormous numbers of spores. As a result, the fat body enlarges and the larvae may become bloated.

96. ***Sarcocystis* in Certain Birds.** GORDON MARSTON CLARK, U. S. Fish and Wildlife Service, Patuxent Research Refuge, Laurel, Md.

During 1957–58 *Sarcocystis* spp. have been identified from a number of birds in Maryland. These include *Sarcocystis rileyi* (Stiles, 1893) from the black duck, *Anas rubripes*, and species of *Sarcocystis* from the great blue heron, *Ardea herodias*, the slate-colored junco, *Junco hyemalis*, the eastern meadowlark, *Sturnella magna*, the redwinged blackbird, *Agelaius phoeniceus* and the common grackle, *Quiscalus quiscula*.

Sarcocystis in the icterid birds and the junco is found primarily in the leg muscles and occasionally in the muscles of the breast, wing, and neck. Since the sarcocysts are small, averaging but 4 × 0.3 mm, close examination is necessary for their identification. In the heron a few long sarcocysts were found in the leg muscles and numerous smaller cysts in the cardiac muscle.

Sections and smear preparations of these pathogens will be presented photographically and sections of muscle from infected birds will be available for microscopic examination.

97. **Observations on the Time and Number of Molts in the Intestinal Phase of *Trichinella spiralis*.** J. B. VILLELLA, Phoenix Memorial Laboratory, University of Michigan.

Experimental infection of white rats with *Trichinella spiralis* revealed that the males and females of this nematode undergo the typical 4 molts during the intestinal phase of the cycle.

In order to determine more precisely the time of each molt, white rats were tube-fed with excysted larvae and then sacrificed at various intervals from 2 hrs to 144 hrs. Immediately after the animal was killed, male and female worms were removed, counted, and examined for evidence of exsheathment.

Examination of female worms showed that the largest percentage of females in the process of molting occurred at 6, 12, 18, and 24 hrs following infection of the host. On the other hand, the first molt in the males was noted at 12 hrs, followed by the 2d, 3d, and 4th molts at 18, 24, and 30 hrs, respectively.

98. **Dilution Egg Counts of *Nematospiroides dubius* in Mice and Rats.** JOHN H. CROSS, JR., CHARLTON DAWSON, J. ALLEN SCOTT, AND ETTA MAE MACDONALD, University of Texas Medical Branch, Galveston.

(See Abstract No. 64)

99. **Guinea Worms in a Raccoon from South Dakota and in Mink from Minnesota.** ERNEST J. HUGGHINS, South Dakota State College, Brookings.

Two Guinea worms, *Dracunculus insignis* (Leidy, 1858) Chandler, 1942, were removed from a raccoon, *Procyon lotor lotor* (Linn.), taken near Gary, Deuel County, South Dakota, in February, 1956. A student, Bill Taylor, brought the worms to the author for identification. He stated that upon skinning the raccoon, he found a worm in each hind leg coiled in the subcutaneous tissue of the thigh. The worms were approximately 23 cm in length. This is the first report of dracontiasis from a wild carnivore in South Dakota, although Benbrook (1940) reported the infection from a dog in Sioux Falls. Both of these reports are from extreme eastern South Dakota.

Guinea worms were found in 3 mink, *Mustela vison letifera* Hollister, trapped near Luverne, Rock County, Minnesota, in November, 1956, by Jud Cooney, also a student at South Dakota

State College. The mink, 1 male and 2 females, were brought to the author for examination. In each of the 3 mink, a single worm was coiled in a bulging cyst in the angle of the tibiotarsal region. The lengths of the worms were 16.3, 20.0, and 25.2 cm. Mr. Cooney stated that while skinning 2 other mink a short time previously, he had encountered similar worms in the legs. He stated further that in the course of his trapping and skinning operations in the same vicinity in previous years, he had noticed similar worms in raccoons as well as in the hind leg of 1 muskrat; unfortunately, he did not save the worms for identification.

A complete report will appear in the Proceedings of the South Dakota Academy of Science, Vol. 37, 1958, with special reference to the possibility of an endemic area being present locally in the region where the States of South Dakota, Minnesota, and Iowa adjoin each other.

100. **Studies on *Philonema agubernaculum*, a Dracunculoid Nematode Infecting Salmonids.** MARVIN C. MEYER, University of Maine.

Adult *Philonema agubernaculum* (Simon and Simon, 1936, Parasitol. **28**: 440–442), occurring beneath the serous membrane, encysted on the viscera or free in the body cavity, is a serious parasite in landlocked salmon (*Salmo salar*) and Eastern brook trout (*Salvelinus fontinalis*) in Maine lakes. The multiple mesenteric and serosal adhesions, evoked by the presence of the worms, may be so severe, especially in older fish, that neither normal spawning nor stripping is possible. This species, like other dracunculoids, is characterized by the relatively enormous length of the females as compared with the midget males, and by the fact that in the course of ontogeny the vulva and vagina atrophy, leaving the body of the gravid female almost entirely occupied by the larvae-filled uterus. When gravid females are placed in water, they move slowly and burst within 2 minutes, protruding a coil of uterus through the ruptured body wall, while, at the same time, literally thousands of larvae are discharged as a teeming white cloud. Larvae have remained viable in lake water for 14 days, during which *Cyclops* sp. were infected. A month later these infected copepods were fed to hatchery-reared, fingerling salmon with inconclusive results. Available forage fish, consisting of lake chubs (*Hybopsis plumbea*), golden shiners (*Notemigonus crysoleucas*), American smelt (*Osmerus mordax*), were examined as possible intermediate hosts, using a modified pepsin-HCl digestion technique. All were found negative for philonemids, although both viable larvae and adult nematodes of other species were recovered.

101. **Ultrastructure at the Surface of Cercariae of *S. mansoni* and of a Plagiorchioid (*Tetrapapillatrema concavocorpa* ?).** F. J. KRUIDENIER AND A. E. VATTER, University of Illinois.

Ultrathin sections of the cercariae of *S. mansoni* and of the plagiorchioid *Tetrapapillatrema concavocorpa* (?) have been studied with an RCA EMU 3 electron microscope following fixation in osmium tetroxide. One group of specimens of each species was fixed after less than 2 hours of emergence time, another after more than 18 hours of emergence. Samples of the fixed specimens were studied histochemically.

Stratification is present at the surface of both species. A basal portion (membrane ?) seems identical in each. Their intermediate and surface areas differ in micromorphology. The outermost portion of *S. mansoni* is a distinct layer. It appears homogeneous in the fresh specimens and is without discrete, distinguishable microstructures. The intermediate layer in this cercaria contrasts sharply with the outermost in the texture of its matrix and contained microelements.

The texture of the outermost portion of the surface layer of *T. concavocorpa* resembles that of the intermediate area. Differentiation can only be based upon the distribution of the several distinguishable microelements. The coordinated histochemical studies indicate that no appreciable loss of surface substance accompanies adequate treatment with osmium tetroxide and that electron microscopy does not adequately indicate the differentiation demonstrated by chemical affinities of surface elements of *T. concavocorpa*.

102. **Systematic Position of the Genus *Dihemistephanus* (Trematoda: Digenea).** L. E. PETERS, Purdue University.

Although existing descriptions of *Dihemistephanus lydiae* from *Mola mola* in European waters are incomplete, Looss' account makes it possible to identify as a species of *Dihemistephanus* a trematode which Manter collected from the same host species in New Zealand. Especially characteristic of the genus is a fleshy protuberance overhanging the genital pore and bearing peculiar tubular pits. The presence of a true seminal receptacle and an external seminal vesicle surrounded by conspicuous prostate cells are not characters of the Acantho-

colpidae, the family to which the genus has heretofore been assigned. On the whole it is in much closer agreement with the Lepocreadiidae. The only respects in which *Dihemistephanus* resembles any of the acanthocolpids more than the usual lepocreadiids are the enlarged cuticular spines in the cephalic region and the papillose armature of the cirrus and metraterm. However, these resemblances are superficial; neither the enlarged spines nor the terminal gonoducts have the arrangement found in the Acanthocolpidae. *Dihemistephanus* therefore does not belong in the Acanthocolpidae but seems instead to have a close affinity with the Lepocreadiidae and probably is an aberrant genus of that family.

103. **Homologies of the Clamp Sclerites of *Chimaericola leptogaster* (Leuckart, 1830) Brinkman, 1942 (Chimaericoloidea: Monogenea) and Related Gill Parasites of Holocephalan Fishes.** W. J. Hargis, Jr., Virginia Fisheries Laboratory, Gloucester Point.

(See Abstract No. 5)

104. **Studies on the Life History of *Mosesia chordeilesia* McMullen 1936 (Trematoda: Lecithodendriidae).** J. E. Hall, Purdue University.

Studies on virgulate xiphidiocercariae from the Tippecanoe and Wabash Rivers, Indiana, have revealed that the larva of *Mosesia chordeilesia* is a virgulate form, *Cercaria neustica* Seitner, and not the microcotylous xiphidiocercaria suggested by McMullen, 1936. The larva of *M. chordeilesia* penetrated and encysted in mayfly naiads (*Hexagenia limbata*) obtained from a locality where naturally infected ones could not be found. The cyst is formed within 1 hour after penetration, and its diameter increases from approximately 0.1 mm to 0.2 mm as the metacercaria grows and adult structures become evident. Experimentally infected naiads containing metacercariae at least 44 days old were fed to 6 newly hatched chicks and 1 young hamster, all of which yielded ovigerous adults of *M. chordeilesia* when examined 3 to 28 days later. The number of worms recovered from the hamster was approximately 115 and from the chicks, 22–171. The wood peewee (*Contopus virens*) was found to be a natural host in the area where infected snails were obtained. Attempts to infect 1 of the snail hosts, *Goniobasis livescens*, by feeding embryonated eggs have been unsuccessful thus far.

105. **Preliminary Report on the Life Histories of a Liver and Kidney Fluke from the Ruffed grouse in Algonquin Park, Ontario, Canada.** Newton Kingston, Ontario Research Foundation.

(See Abstract No. 4)

106. **Some Trematodes of the Genus *Hasstilesia* from Unusual Hosts.** Edwin J. Robinson, Jr., Kenyon College.

Hasstilesia from the marsh rabbit, *Sylvilagus palustris*, and the red fox, *Vulpes fulva*, are demonstrated, and their characteristics compared to those of *Hasstilesia tricolor*.

107. **A New Strigeid Trematode (Diplostomatidae: Alariinae) from the Pancreatic Duct of the Raccoon.** Reinard Harkema and Grover C. Miller, North Carolina State College.

Examination of a raccoon on December 15, 1957, revealed the presence of 86 specimens of a trematode in the pancreatic duct. These worms had caused marked hypertrophy of the pancreatic duct and consequent swelling of the pancreas. The specimens proved to be a strigeid which is sufficiently different from any known form to constitute a new genus. This trematode is characterized by the presence of a very large, elongated holdfast organ contained within an elongated pouch of the ventral body wall. In this respect it is similiar to the genus *Duboisiella*, but differs from it in the structure of the holdfast, which is not lobed; testes side by side; the absence of an ejaculatory pouch; and the presence of pseudosuckers. It also shows similarity to *Pharyngostomum* and *Pharyngostomoides* in the arrangement of the testes. However, the distinctive holdfast and ventral pouch separate it from these genera.

108. **Some Trematodes from Turkey and Egypt.** William H. Coil and Robert E. Kuntz, U. of Nebraska, Lincoln, and U. S. Naval Research Unit No. 2, A.P.O. 63, San Francisco.

109. **Effects of Colchicine on *Hymenolepis nana*.** F. J. Etges and M. J. Sirkin, The University of Cincinnati.

Recent work (Schiller, E. L., 1957, J. Parasitol. **43** (Suppl.): 23) indicated the effect of X-irradiation on the structure of *Hymenolepis nana*. In the present investigation, colchicine

was used in an attempt to induce variations in tapeworm morphology, since it is a known mitotic inhibitor which could interfere with proglottid-formation at the neck region of adult worms.

Oral doses of colchicine solution (1:1000) were administered to white mice naturally infected with *H. nana*. The periods of treatment varied, depending on survival of the mice. The total quantity of colchicine administered to any one mouse varied from 0.1–0.5 mg. Control and experimentally treated worms were recovered upon autopsy, and fixed in AFA. Specimens were stained and mounted, both sectioned and *in toto*.

No variations were seen in controls that resemble the experimentally treated animals. Morphological variations observed included: Incomplete separation of proglottids; failure to produce genital pores in all segments, resulting in 2 or 3 male ducts emptying through 1 pore of an adjacent segment; partial duplication of the seminal receptacle; reduction or absence of testicular tissue; failure to produce eggs in all but a few proglottids; and abnormally formed and enlarged eggs.

Results indicate that colchicine acts as an inhibitor in morphologic differentiation of proglottids. Further, *H. nana* appears to have limited ability to regulate its structural relation with other proglottids when colchicine alters normal structure. Such induced variations make reconsideration of intraspecific variation in the genus *Hymenolepis* important.

110. **Structures in the Oncosphere of *Hymenolepis diminuta*, a Cestode in Rats.** R. E. OGREN, Dickinson College, Carlisle, Pa.

This tapeworm has been used for many years in life history and physiological studies. However, no detailed description of the embryo exists. The oncosphere is a typical hexacanth embryo and develops from a spherical morula. The body is composed of contractile parenchyma enclosed by a cuticle. Three pairs of characteristic hooks are present, a medullary center and granule-filled epidermal glands. The embryo is enclosed by an outer shell capsule and an intermediate colloidal cushion or pseudoembryophore.

111. **Free Amino Acid Content of the Tropical Rat Mite, *Ornithonyssus bacoti* (Hirst: 1913).** E. AHMED ZEIN-ELDEN AND J. ALLEN SCOTT, University of Texas Medical Branch, Galveston.

(See Abstract No. 35)

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1931	WILLIAM A. RILEY		ASA C. CHANDLER
1932	MAURICE C. HALL*		WILLIAM H. TALIAFERRO
1933	WILLIAM H. TALIAFERRO		FRED C. BISHOP
1934	ERNEST E. TYZZER		JAMES E. ACKERT
1935	CHARLES F. CRAIG*		HARLEY J. VAN CLEAVE*
1936	ROBERT HEGNER*		WILLIAM B. HERMS*

1937	George R. La Rue		David H. Wenrich
1938	Fred C. Bishop		Elery R. Becker
1939	Horace W. Stunkard		Henry E. Meleney
1940	David H. Wenrich		Gotthold Steiner
1941	James E. Ackert		Justin Andrews
1942	Henry E. Meleney		Rudolph W. Glaser*
1943	Henry E. Meleney		Rudolph W. Glaser*
1944	Henry E. Ewing*		Benjamin Schwartz
1945	Asa C. Chandler		Donald L. Augustine
1946	Norman R. Stoll		Harold Kirby, Jr.*
1947	Harley J. Van Cleave*		Clay G. Huff
1948	Ernest C. Faust		Cornelius B. Philip
1949	Thomas W. M. Cameron		Willard H. Wright
1950	Willard H. Wright		Harold W. Manter
1951	Benjamin Schwartz		Eloise B. Cram*
1952	Emmett W. Price		Paul D. Harwood
1953	Cornelius B. Philip	Elery R. Becker	Harold W. Brown
1954	Elery R. Becker	Clay G. Huff	Donald B. McMullen
1955	Clay G. Huff	Eloise B. Cram*	Gilbert F. Otto
1956	Eloise B. Cram*	Gilbert F. Otto	Aurel O. Foster
1957	Gilbert F. Otto	Arthur C. Walton	Allen McIntosh

* Deceased

Secretary-Treasurer

William W. Cort	1925; 1926; 1927; 1928; 1929
Norman R. Stoll	1930; 1931; 1932

Secretary

Horace W. Stunkard	1933–34; 1935–36; 1937
Oliver R. McCoy	1938–39; 1940–41; 1942
James T. Culbertson	1942–43; 1944–45; 1946–47
Harold W. Brown	1948–49; 1950–51
Arthur C. Walton	1952–53; 1954–55; 1956
Paul E. Thompson	1957–

Treasurer

Justin Andrews	1933–34; 1935–36
Gilbert F. Otto	1937–38; 1939–40; 1944
Lloyd E. Rozeboom	1941–42; 1943
Robert M. Stabler	1945–46; 1947–48; 1949–50; 1951–52; 1953–54; 1955–56; 1957–

Council Members at Large

Paul Bartsch	1925–28	Clay G. Huff	1940–43; 1944–46; 1948–51
Fred C. Bishop	1925; 1926–28 1929–30	H. W. Stunkard	1940–43
Robert Hegner*	1925–27	D. L. Augustine	1941–44
Charles A. Kofoid*	1925	Willard H. Wright	1942–45; 1946–48
B. H. Ransom*	1925	Raymond M. Cable	1942–45; 1954–57
William A. Riley	1925–26; 1928–30	Gilbert F. Otto	1942–44; 1945–48
Charles W. Stiles*	1925; 1929–32	Harold W. Manter	1944–46
Ernest E. Tyzzer	1925–26	Harold W. Brown	1944–47
Maurice C. Hall*	1926–29	G. Robert Coatney	1945–48
Wilson G. Smillie	1926–27	T. W. M. Cameron	1946–48
Henry B. Ward	1926–29	Cornelius B. Philip	1947
Franklin D. Barker*	1927–30	Martin D. Young	1947–50
J. H. St. John*	1927–28	Paul D. Harwood	1948–51
W. H. Taliaferro	1928–31	J. C. Swartzwelder	1949; 1950–53
Asa C. Chandler	1929–30; 1936–39	J. T. Culbertson	1949
William B. Herms*	1930–33	George L. Graham	1949–52
Benjamin Schwartz	1930–33	Lloyd A. Spindler	1949–52
L. R. Cleveland	1931	George W. Wharton	1950–53

William W. Cort	1931–34; 1935–38	Donald B. McMullen	1951–53
H. E. Ewing*	1931–32	Arthur C. Walton	1951
Ernest C. Faust	1931–34; 1938–41	Paul C. Beaver	1952–54; 1956–
John F. Kessel	1932–35	Elon E. Byrd	1952–55
David H. Wenrich	1932–35; 1936	Chester A. Herrick*	1952–55
Henry E. Meleney	1933–36	Allen McIntosh	1953–56
Norman R. Stoll	1933–36; 1937–40; 1941	Donald V. Moore	1953–56; 1957–
		Aurel O. Foster	1954–55; 1957
Eloise B. Cram*	1934–37	Lloyd E. Rozeboom	1954
Wilbur A. Sawyer*	1934–37	Luther O. Nolf	1955–
James E. Ackert	1935–38	Leslie A. Stauber	1955–
Earl C. O'Roke*	1936–39	Francis J. Kruidenier	1956–
Justin Andrews	1937–40	William Trager	1956–57
H. J. Van Cleave*	1938–41	Gordon H. Ball	1958–
Elery R. Becker	1939–43	Dale A. Porter	1958–
Emmett W. Price	1939–43; 1944–46; 1947–50	Paul P. Weinstein	1958–

* Deceased

Council Members—Ex-officio

In addition to the President, President-Elect, Vice President, Secretary, and Treasurer, the following are *ex-officio* members of the Council:

Since 1942: Chairman of the Editorial Committee

N. R. Stoll	1942–43
H. W. Stunkard	1944–47; 1949–53
W. W. Cort	1948
G. R. La Rue	1954–55
Leon Jacobs	1956–

Since 1952: Custodian of Back Issues

G. F. Otto	1952–53
W. S. Bailey	1954–56; 1957–

Editorial Committee of the Journal of Parasitology

William W. Cort, Chairman	1932–37; 1948	David H. Wenrich	1944–48
		Justin M. Andrews	1949–53
Robert Hegner*	1932–34	Cornelius B. Philip	1951–53; 1954–55
Francis M. Root*	1932–34	George R. La Rue, Chairman assisted by	1954–55
William A. Riley	1934–37; 1938–42; 1943; 1944–48; 1949–50	Everett E. Lund	1955
		Clay G. Huff	1954–55
William H. Taliaferro	1934–37; 1938–42; 1943	Leon Jacobs, Chairman	1956–
Norman R. Stoll, Chairman	1938–42; 1943	Harold W. Manter	1956–
		Bernard V. Travis	1956–57
Horace W. Stunkard, Chairman	1944–47; 1949–53	Herbert T. Dalmat	1958–

* Deceased

Editorial Board of the Journal of Parasitology

C. F. Craig*	1932–33; 1934–37	G. R. La Rue	1932–36; 1957–
M. C. Hall*	1932–33	D. H. Wenrich	1932–36; 1938–41
H. B. Ward*	1932–33	E. C. Faust	1933–37
A. C. Chandler	1932–34; 1935–38; 1939–42	Benjamin Schwartz	1933–37; 1938–41; 1942–45
C. A. Kofoid*	1932–34; 1935–38	E. R. Becker	1934–35; 1936–39; 1948–51
W. A. Riley	1932–34; 1951–53		
W. H. Taliaferro	1932–34	Robert Matheson	1935–38
J. E. Ackert	1932–35	O. R. McCoy	1936–39
R. P. Strong*	1932–35; 1936–39	H. E. Ewing*	1937–40

F. C. Bishop	1932–36
H. J. Van Cleave*	1937–40
W. W. Cort	1938–41; 1942–45; 1946–47; 1949; 1950–53; 1954–57
C. B. Philip	1939–42; 1950
E. E. Tyzzer	1939–42
H. W. Brown	1940–43
H. W. Manter	1940–43
R. D. Manwell	1940–43
R. P. Hall	1941–44
E. H. Hinman	1941–44
J. F. Mueller	1941–44
Harold Kirby, Jr.*	1942–45; 1951–52
B. G. Chitwood	1943–46
Rudolf Glaser*	1943–46
P. P. Levine	1943–46
L. T. Coggeshall	1944–47
J. T. Lucker	1944–47; 1950–53
N. R. Stoll	1944–47; 1948–51; 1952–55
W. L. Jellison	1945–48; 1949–52; 1953–54
C. W. Rees	1945–48
L. A. Spindler	1945–48; 1951–54
J. F. Kessel	1937–40
R. M. Cable	1946–48; 1951–54; 1955–
L. E. Rozeboom	1946–49
R. J. Porter	1947–50
William Trager	1947–50
A. C. Walton	1947–50
G. H. Wharton	1948–51
E. E. Byrd	1949–52; 1953–56
G. R. Coatney	1949–52; 1953–56
M. D. Young	1951–54
Allen McIntosh	1952–55; 1956–
L. J. Olivier	1952–55
William Balamuth	1953; 1954–57
H. W. Stunkard	1954–57
C. G. Goodchild	1955–
P. E. Thompson	1955–
G. M. Kohls	1955–56; 1957–
R. Barclay McGhee	1956–
P. P. Weinstein	1956–
C. P. Read	1957–
D. L. DeGiusti	1958–
Q. M. Geiman	1958–
R. M. Lewert	1958–

List of Meeting Places

1925 Kansas City	1934 Pittsburgh	1943 (No meeting)	1951 Chicago
1926 Philadelphia	1935 St. Louis	1944 Cleveland	1952 Ithaca
1927 Nashville	1936 Atlantic City	1945 St. Louis	1953 Madison
1928 New York	1937 Indianapolis	1946 Boston	1954 Memphis
1929 Des Moines	1938 Richmond	1947 Chicago	1955 Atlanta
1930 Cleveland	1939 Columbus	1948 New Orleans	1956 Storrs
1931 New Orleans	1940 Philadelphia	1949 New York	1957 Philadelphia
1932 Atlantic City	1941 Dallas	1950 Cleveland	1958 Bloomington
1933 Boston	1942 New York (cancelled)		

IN MEMORIAM

Earl C. O'Roke

Charles Robert Rein

Edward G. Reinhard